

# EXE

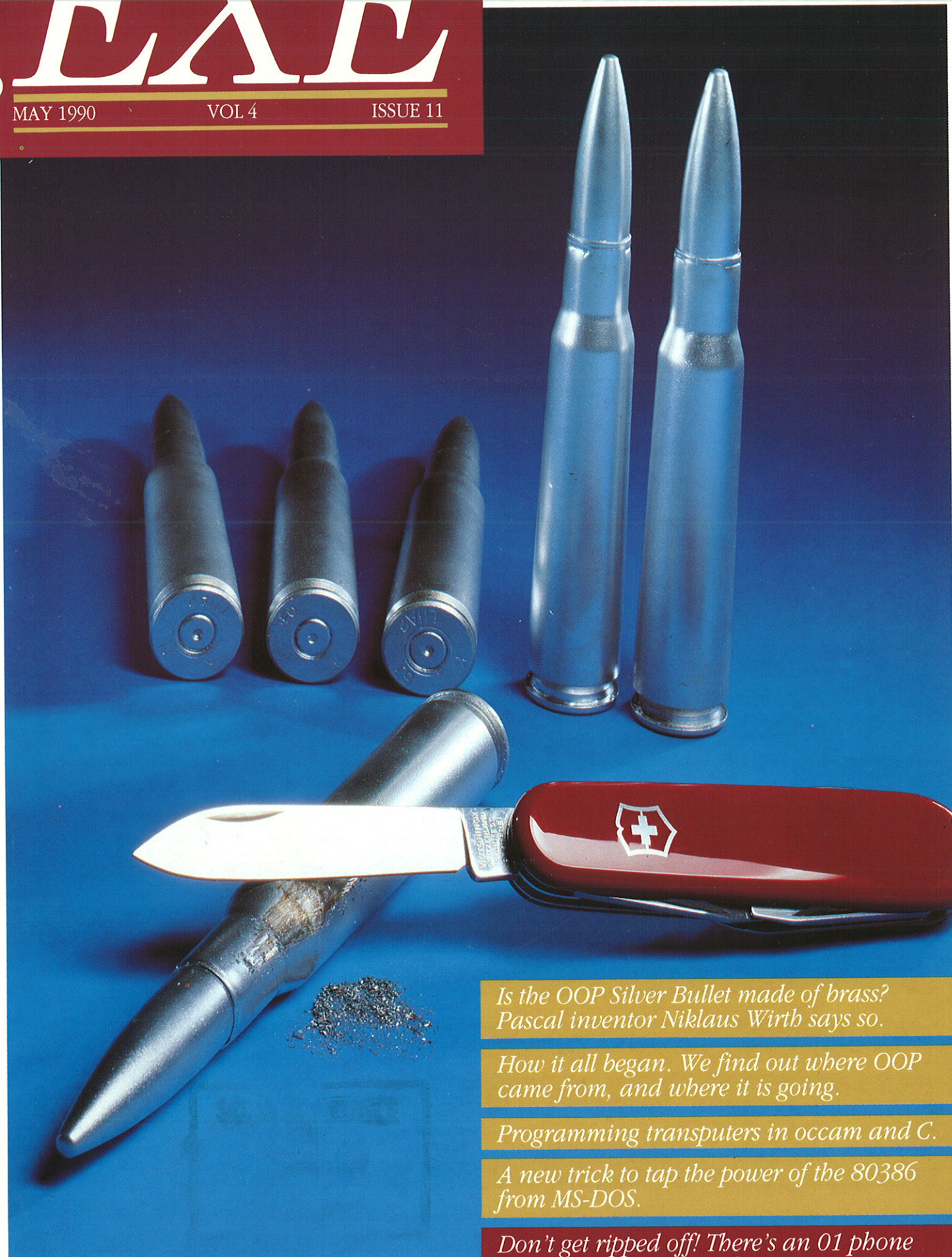
MAY 1990

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*The Software Developers' Magazine*



*Is the OOP Silver Bullet made of brass?  
Pascal inventor Niklaus Wirth says so.*

*How it all began. We find out where OOP  
came from, and where it is going.*

*Programming transputers in occam and C.*

*A new trick to tap the power of the 80386  
from MS-DOS.*

*Don't get ripped off! There's an 01 phone  
number converter inside.*



## Applications and Systems Programmers

# What comes after C?

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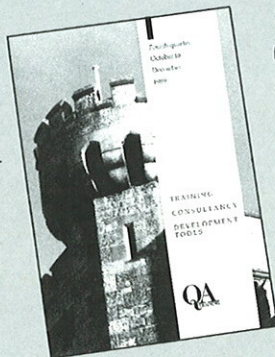
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**OOP MEETS MODULA-2**

The object oriented movement has such a strong momentum these days, it would take the doubts of a figure of enormous authority to slow it down. Such a figure is Niklaus Wirth, and he does indeed have doubts.

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**HISTORY OF A USEFUL ILLUSION**

OOP may owe its existence to an attempt by the post-war Norwegian Government to build a nuclear power industry on the cheap. Richard Drake traces the twists and turns of OOP from its origins through to today.

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**THE TAMER TRANSPUTER**

There have never been more ways to program transputer systems. David Gristwood looks at two C-based packages for PC transputer boards: 3L's Parallel C and Perihelion Software's Helios-PC.

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Occam's reputation as a difficult language has played an important part in preventing the transputer from taking off. Yet when you look into it, occam is a simple and elegant solution to a complex problem, as John Wexler explains.

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This month, London's 01 phone number prefix changes to 071 and 081. A lot of expensive software is being touted to update databases automatically. If you have bought any, you won't want to read Dave Atkins' article.

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As everybody knows, the 80386 processor has a 4 GB address space, restricted to 1 MB when running MS-DOS. Everybody, that is, except David Bailey, who has found a way of unleashing the 80386's power without using protected mode.

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Windows programmer Dave Jewell is worried about his eyesight, and is frustrated by the amount of time he spends rebuilding his applications. He thinks that a new development tool from Whitewater, the Actor people, may help.

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Borland's Paradox database, although gaining in popularity at the expense of dBASE and its clones, suffers from being inaccessible from languages such as C. Andy Redfern takes a look at the product which puts this right.

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Five years after the first Graphical User Interface for the PC appeared, we are still running character-based applications. Are things ever going to change?

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Three volumes this month; covering converting between PC applications' file formats, PC systems programming in detail and the FoxPro database.

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We have a sour view of the ANSI committee for FORTRAN standardisation, some technical minutiae of serial communications and a heart-rending plea from Eastern Europe

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Somebody's been hacking at a bulletin board. Ms Stob suspects those awfully nice Australian people from that frightfully well-acted television programme.

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**Reacting to Readers**

Our annual Reader Survey gives us an insight into the tools, methods, language and hardware that is being used, and that will be used in the process of software development.

We aim to keep in touch with software developers as much as possible. For this reason, we hold twice-yearly meetings at the .EXE offices and around the country, where readers can talk directly to the editorial staff and suggest ways in which the Magazine could be improved.

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# Not GUI enough

Apart from when I am giving it an occasional treat, my PC runs in text mode. The applications that I use - a word processor, plus a myriad programmer's utilities, sampled in the line of duty - are all character based. To link an object module, I type 'LINK PROG;'. I do not pick up the object file icon with the mouse and drag it over to the linker icon (which, by the way, is a picture of a short length of chain, in the bitmap of my imagination). As a non-GUI PC user, I am not unusual. For example, if you, as a .EXE reader, have had any OS/2 experience, then you may count yourself as one of the privileged few - a recent survey suggested that you are outnumbered several times by your UNIX brethren.

Now this is something of a disappointment. It is five years since I first saw a GUI running on a PC. By 1990, said the magazine editorials of 1985, we shall all be utter WIMPs: forever resizing windows and double-clicking like good 'uns. (It was always 'WIMP' in those days, 'GUI' seemed to come much later; perhaps because buzzwords, like lithium batteries, wear out after a few years, and must be replaced with an equivalent.) Our keyboards, said the pundits, will shrivel and drop off from lack of use. And at the time, to a naive *Tomorrow's World* believer like myself, this seemed almost as plausible as cheap, safe nuclear power. Indications of the problems to come - such as the turgid response of the old Apricot F1 running GEM, where the machine seemed to have barely enough power to animate the mouse cursor - were cheerfully ignored.

The reasons for the failure of GUI on the PC - for failure is what it is - are various. I have already mentioned performance. Mac users may not mind the slowness of bit-mapped graphics, but they are not able to make a direct comparison with a character-based application. Try talking to a Real User who has been 'upgraded' from, say, Lotus 1-2-3 to Microsoft Excel, but is still working on the same machine; and see how well-pleased he is with the switch. The search for swift response times may lead to poor software design, but as a saleable feature, it still beats alleged compatibility with vapourware into a cocked hat.

There is also the matter of creating the software. You don't have to be Adele Goldberg to knock out a program that lets the operator specify options using a row of 'check boxes', but I bet you could produce a menu-driven program, driven by the keys '0' - '5' in a fraction of the time. No doubt the general introduction of OOP languages will narrow the gap. Notice, incidentally, that, once again, this problem has long since been overcome on the Mac.

Are we still waiting for the right implementation? Digital Research's GEM does not seem a realistic option, unless you plan to port the DTP package that you have written to the Atari ST range. Windows, although it has enjoyed more success recently, and is about to be upgraded again, has always had a slight smell of death to it: Windows is, after all, sitting on top of MS-DOS, and it has been drilled into us that MS-DOS is doomed. The OS/2 V2.0 requires 6 (six!) MB of RAM to run; your software will need to be spectacularly good to justify your customer's hardware investment.

And so comes the dismal realisation. It's not that GUI hasn't really happened for PC-class machines; it is the feeling that it is never going to happen; we are always going to have factions of users backing diverse systems, with the majority using text-based systems. Any window (sorry about that) of opportunity for creating a *de facto* PC standard has passed. I'm a fan of GUIs, and feel sure that, eventually, all interactive software on small machines will be written this way, for the same reason that cars now all share the same arrangement of three pedal controls, despite historic difficulties of standardisation. I'm worried that, on the car that I drive now, they are still quarrelling about whether to put the throttle on the left or in the middle.

WRW



## THE C LANGUAGE

Microsoft C V6 is a complete rewrite with improved optimisation and a new Programmer's Workbench. High C V1.6 has been considerably improved, with better Microsoft C compatibility, and new documentation.

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## Microsoft C V6.0

Microsoft has launched, and is now shipping, Microsoft C V6.0 Professional Development System. Bad news first: it's an enhanced version of V5.1, which provides neither 32-bit code generation nor OOP support. Windows and OS/2 development still requires the purchase of extra tools. The optimiser, however, has been totally rewritten, and Microsoft's figures say that the average compiled program will now be 10% smaller and 7-10% faster. Optimisation can now be controlled by embedded pragmas. There is a tiny memory model for producing .COM files - an unexpected lurch towards Zortech compatibility. New language features include the introduction of an alternative fast calling convention (arguments are passed in registers instead of on the stack) and a new based pointer type. These are 16-bit pointers which are interpreted as offsets to a segment specified in the declaration. It's best explained with a fragment of code:

```
_segment seg;
char _based(seg) *string;
char _far *farstring;
/*.....*/
/* Get a based heap */
seg = _bheapseg(HEAPSIZE);
/* Get space for string */
string = _bmalloc(seg, STRLEN);
_fstrcpy((char far*)string, farstring);
```

Note the use of the new reserved words `_segment` and `_based` in the declarations, and that the based pointer is usually treated as a far pointer. However, the compiler can make extra optimisations

with the based type when performing pointer arithmetic. Personally, I will need some convincing that this justifies further complicating the mess which is pointer handling in 80x86 C compilers. QuickC is no longer bundled, but there's a Quick Compilation switch on the main compiler, which turns off the optimiser. (QuickC itself has been upgraded to version 2.5, and is sold separately.) There's also an incremental compilation switch, which restricts compilation to the parts of a program which have changed - but this can only be used if the Quick Compilation switch is also set. A new inline assembler lets you embed assembly language within C source code. Microsoft is claiming ANSI Standard compatibility for the product, except that double-byte characters are not supported.

The Programmer's Workbench is a WIMP-based front end from which you can call the compiler, linker etc. There is also a source code browser, which shows you the hierarchy of procedure calls, plus the various interdependencies. The Workbench can record the compilation switch settings for each module, and you can have different settings for, say, the release version and the development version of a project.

The CodeView debugger is now up to version 3, and boasts a new interface that fits in with the Workbench. There's still no facility for remote debugging using two machines and a serial port, but CodeView will now sit in extended or expanded memory, allowing you to debug larger programs. RRP £335.

source code. It is compatible with the Microsoft, Borland, Zortech and Lattice C compilers. For more information, contact the manufacturer on 0101 214 248 2561.

## Pi not irrational

PiEdit is a programmer's editor which comes in three versions: MS-DOS (£195), OS/2 (£249) and UNIX/XENIX (£349). As you may guess from these prices, it does rather more than EDLIN. There is support for multiple files in multiple resizable windows, a macro language, automatic backups of current files after a given number of keystrokes, syntax checking for C, C++, dBASE, Pascal and a few other languages, background printing, complete 'customisability' and an off-line/batch editing capability. The feature that is being pushed hardest, though, is PiEdit's 'undo' facility. The program maintains a 32 KB buffer of your keystrokes, which you can undo *selectively* - so it is possible to correct an error without losing subsequent edits. PiEdit is distributed in the UK by IDS (071 631 0548).

## On Form

APForm is an add-in program for Borland's Paradox 3. Run from within the Paradox environment, the utility allows the easy creation of both forms and reports with complex lines and boxes. Priced at £59, it is distributed by Dunstan Thomas Ltd (0705 822254). The company also supplies a range of other Paradox development tools.

## PC Check

PC Check is a PC diagnostic program aimed at OEMs and system resellers. It is a software package which tests all the facilities of a PC compatible computer. After determining the configuration and performing tests on the RAM (including the extended and expanded flavours), disks, display adapter, keyboard and even the printer, the program produces a diagnostic report. The package comes from Eurosoft Ltd (0202 297315).

## SoftPC

Insignia Solutions' SoftPC package runs on the Macintosh, making it into a PC/XT emulator. Now the company has introduced an add-on module, which lets the Mac emulate an AT with EGA graphics. The emulation is incomplete, though; it doesn't do 80286 protected mode and can't handle OS/2. The software is priced at £299 for the base SoftPC package and £149 for the EGA/AT add-in module. Insignia is on 0494 459426.

## Fast 486

Intel may not be producing any 33 MHz 80486 chips yet, but why should a little thing like that stop anybody from producing a 33 MHz 486-based machine? AMT's MicroFrame 433 has these specifications; it is based on a hand-screened CPU (nominal clock rate: 25 MHz) and costs about £8000 for a system with 140 MB hard disk and colour VGA. AMT says that it is the world's first; talk to the company on 081 450 3222.

## Windows Prolog

Quintec has released a version of its Prolog compiler for the Microsoft Windows/386 environment. According to the manufacturer, the product makes extensive use of the Windows facilities, providing support for graphics, icons, menus and so on. A single copy of the package costs £1800. Quintec's phone number is 0865 791565.

## DataComms Book

VNU (071 4394242) has published the fourth edition of *The DataComms Book*, a comprehensive directory of data and telecommunications. The book costs £57 including UK p&p.

## Financial library

Greenleaf Software Inc, well-known for its range of C libraries running under MS-DOS and OS/2, has produced a new version of its Financial MathLib (previously called 'Business MathLib') package. The software consists of a suite of arithmetic functions based on the proprietary 'DEC' number representation system, which uses 11 bytes to store numbers of up to 18 digits of accuracy, with a floating decimal point. Using DEC numbers, the programmer is able to maintain much greater control over rounding errors and other inaccuracies which traditional floating-point number systems introduce into code. The DEC type is supported by trigonometric, statistical and financial functions (such as loan amortisation and depreciation), as well as the more straightforward arithmetic, I/O and type conversion routines.

Greenleaf says that the new version of the library runs up to five times as fast as the previous release. Financial MathLib is priced at \$395 US, which includes the



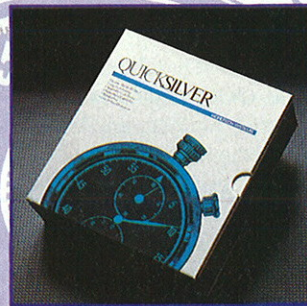
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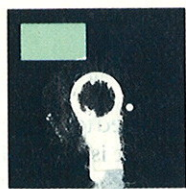
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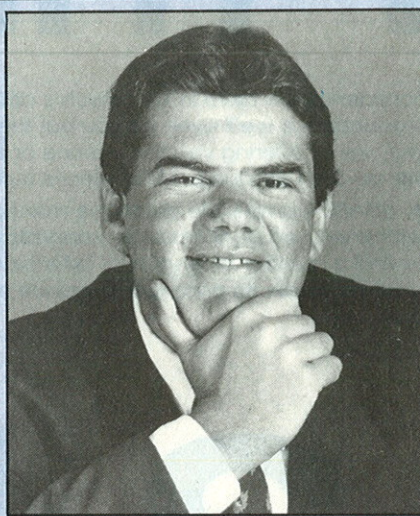
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## Kahn not cant

Philippe Kahn, President of Borland, was in London recently, to address a packed audience of students and lecturers at the Computer Science Faculty of Imperial College. His chosen subject was Object Oriented Programming. Kahn compared the current vogue for OOP with the similar fashion for AI in the early 1980s. Since that time, instead of taking over the world, the commercial application of AI has been increasingly confined, so that now it is used only in niche markets. Kahn claimed that the vital difference between the technologies - the thing that would make OOP take off - is the fact that some OOP languages are supersets of existing mainstream languages. This despite the imperfections of the underlying languages; he described C as 'PDP-11 assembler'. He predicted that, by 1999, the standard teaching language would be Pascal with objects, the most widely used development system would be C++, and that President Dan Quayle would have endorsed Object BASIC.

Concerning the more immediate future, I asked Mr Kahn about imminent release of Borland's own Turbo C++ V1.0 (expected late May). In a recent interview, Bjarne Stroustrup himself had expressed



worries about this product, because Borland had not purchased a copy of AT&T's V2.0 language specification. Mr Kahn promised that the Borland implementation would be completely compatible with V2.0, and would include a full set of class libraries (Zortech's rival product omitted V2.0 stream libraries), so presumably the company has acquired a second-hand copy of the spec.

The release of the Turbo Debugger V2.0 package, which we featured in March '90 issue, is to be held back to coincide with the release of Turbo C++.

## X User Group

You will have to move fast to get to the European X User Group's Spring Conference, to be held in Cambridge on 4th May, so this item serves mainly to alert interested parties to the existence of EXUG (phone: 0954 211860), and to make an appeal to conference organisers, who would like to be mentioned in .EXE's news pages, to send us the information at least two months in advance. We have had a lot of matter relating to April events come in recently, when we were nearly past the deadline for May.

## Lattice RPG

Lattice has released V3.1 of its RPG II Development System. The new version has an enlarged data area, and also supports dynamic link libraries, so it is now possible to port larger System 3X programs down to the PC. Unusually, the compiler itself is protected, following heavy pirating of previous releases. Lattice's UK distributor is Roundhill Systems. Last time I mentioned them, I produced an out-of-date number, so my apologies and the correct number: 0672 84535.

## R without K

They have an impressive list of speakers at the UKUUG conference, to be held in London 11th-13th July, including one Dennis Ritchie (yes, that Dennis Ritchie) who will be talking about C, and Rob Pike, also from AT&T Bell Labs, whose subject will be the planned successor to the UNIX OS, currently dubbed 'Plan 9'. You don't have to be a UKUUG member to register, but it will cost you around £300. Details on 0763 73039.

## Menu Works

If you shepherd a flock of ignorant end users, who need protecting from the rigours of the MS-DOS environment, you might consider a £34.50 program called Menu Works. The program installs itself and produces a hierarchy of menus, based on the applications that it finds already present on the machine. You can customise these menus, for example, password protecting certain applications, and there is even a simple programming language. Menu Works is available from BCS Ltd (081 308 0291).

## Graphic DESQview

Quarterdeck has announced a graphical version of its MS-DOS multi-tasker DESQview. The new package will be based on X Windows, and will allow PC class machines to run DOS and X tasks simultaneously. The software is scheduled to ship in August.

## Phonebase

In September, British Telecom's Directory Enquiries service goes on-line. You'll be able to access the system with a modem, and you'll have access to the same system currently used by the operators when you call the service the normal way. If you want to try out the system now, and have access to a 1200/75 baud modem, call 0800 919199. That's the Phonebase service desk, who will issue you with a temporary user id and password over the phone, and will send you an application form for a permanent one. There's no charge for using the service, apart from the phone call itself, which is charged at 'b' rate, which is around 5p per minute.

## C's conscience

All C programmers have heard of UNIX's lint utility, so-named (according to apocryphal legend) because it extracts bits of fluff from C code. I've used Gimpel Software's PC-lint product in the past, and think that it deserves a different metaphor. PC-lint is the programmer's conscience - it's very hard and tiresome to do its bidding, but if you don't, you will eventually meet your Day of Judgement.

This is a preface to the news that PC-lint has now reached V4.0. There are 70 new

reproachful diagnostic messages that the program can generate as it busybodies its way through your code. I think my favourite, which will save you time rather than pick up mistakes, is the message that warns of redundant #include files. There are 28 so-called Elective Note messages, which draw each and every cast (explicit and implicit) to your attention. This is fussy even by PC-lint's standards - it's intended as a porting aid - which is recognised by the fact that these messages default to off.

Gimpel Software always includes a new 'spot the bug' challenge with each subsequent release of PC-lint. Here is the latest offering:

```
#if PROTOTYPES
double sqrt(double);
#else
double sqrt();
#endif

main()
{
    printf("sqrt(2) = %g\n", sqrt(2));
}
```

Anybody who is forced to type this in and run it to find out what is wrong is utterly weak and feeble, and should be struck off the Holy Role of C Programmers (I would say that, because I have got the crib). PC-lint V4.0 is available directly from Gimpel in the US (0101 215 584 4261), priced \$139.



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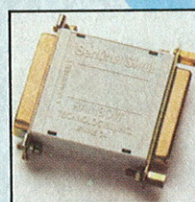
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## Don't Blink

Nantucket's Clipper compiler is notorious for generating memory-inefficient code, and a series of products has been released which address this problem. The latest is BLINKER, a dynamic overlay linker, which is produced by the gloriously named US company Blink Inc. The manufacturers claim that BLINKER is six to ten times faster than rivals PLINK86plus and .RTLink, and, because it can automatically create overlay units, it cuts the amount of memory required to run applications by up to 50%. Other features include transparent memory defragmentation, serial number encryption, the ability to 'burn-in' Clipper environmental variables (and so avoid the need for lines like 'SET CLIPPER = F50' in your customer's AUTOEXEC) and the suppression of an application's attempts to use expanded memory - apparently necessary because of a bug in Clipper's LIM handler.

BLINKER costs £189 from its UK distributor QBS Ltd, whose telephone number is 081 994 6477.

## CompuServe in Europe

CompuServe is an on-line mail and file transfer system, like CIX and BIX. After 10 years in business in the US, it has 550,000 subscribers, which makes it the largest system of its type. Now the company has launched CompuServe Forum, a collection of access points that encourage European use of the system. Before now, access from outside the US has required expensive in-

ternational phone calls, or use of the International PSS network.

The system currently has around 900 databases, where subscribers discuss computing, programming and a lot of non-technical subjects too. There are also several text databases, and direct contact with technical support people from various hardware and software companies.

Access from any European country currently costs \$12.50 per hour (everything's still in dollars) for speeds up to 2400 bps. From the UK, access is via the Istel network, which is an extra \$9.50 per hour, which is around £13 in total. This is around half the price of using the international PSS routes. Details from 0800 289378.

## Pecan on UNIX

Pecan's Pascal compiler is based on the UCSD P-code system. The compiler produces special pseudo object code ('P-code'); this is interpreted to the native machine-code equivalent at run time. There is also an integrated editor and file system, which sit 'on top' of the host operating system, making its operation very machine-independent. It was first devised in the early days of Pascal to minimise porting effort, and so speed up the spread of the language to new platforms.

This being the case, it is surprising that, until now, Pecan Pascal has not been available for SCO UNIX. The compiler costs £1200 ex VAT, and is available directly from the manufacturer in Bristol (phone 0272 425012).

## Boot card

US-based Award Software has produced a PC card which can boot up a machine by itself. The card is based on a ROMmed version of DR DOS, and is primarily intended for diskless workstations, freeing them from the need to boot off the network. US price is \$199, the company's phone number is 0101 408 370 7979.

## Very Sharp

The PC-6220, Sharp Electronics's newly-announced portable, sounds like a masterpiece of miniaturisation. With dimensions of 8.5" x 11" x 1.4", and weighing 6 lbs with battery, the machine has a 12 MHz 80286 CPU, 20 MB hard disk, 1MB RAM and a VGA screen based on colour LCD technology. The only thing missing is a floppy disk drive. The machine should ship in June, when price details will become available.

## Giants merge

Lotus, king of the spreadsheets, is planning to merge with Novell, the network company. The resulting giant would become the largest microcomputer software company in the world - ahead of Microsoft itself. The merger is expected to go through in July.

## RISC mainframe

Thame Microsystems (0844 261456) has announced a range of 88000-based workstations. The Opus Personal Mainframe range runs UNIX on its RISC processor - and MS-DOS on a secondary 80x86 processor, which also handles I/O to the main CPU. The machine also has AT compatible expansion slots, so the workstation can use cheap peripherals.

## Panel Plus

Panel Plus is a well-reputed screen management library for C compilers. The newly released V2.1 of the package has improved CUA conformance, support for the Microsoft C Professional Development System V6.0 (including OS/2 DLLs), Watcom and Metaware 386 compilers and a QuickHelp-compatible help database of the routines. The price, which includes source code, is £295, the supplier is Roundhill (0672 84535).

## EC okays Pirates

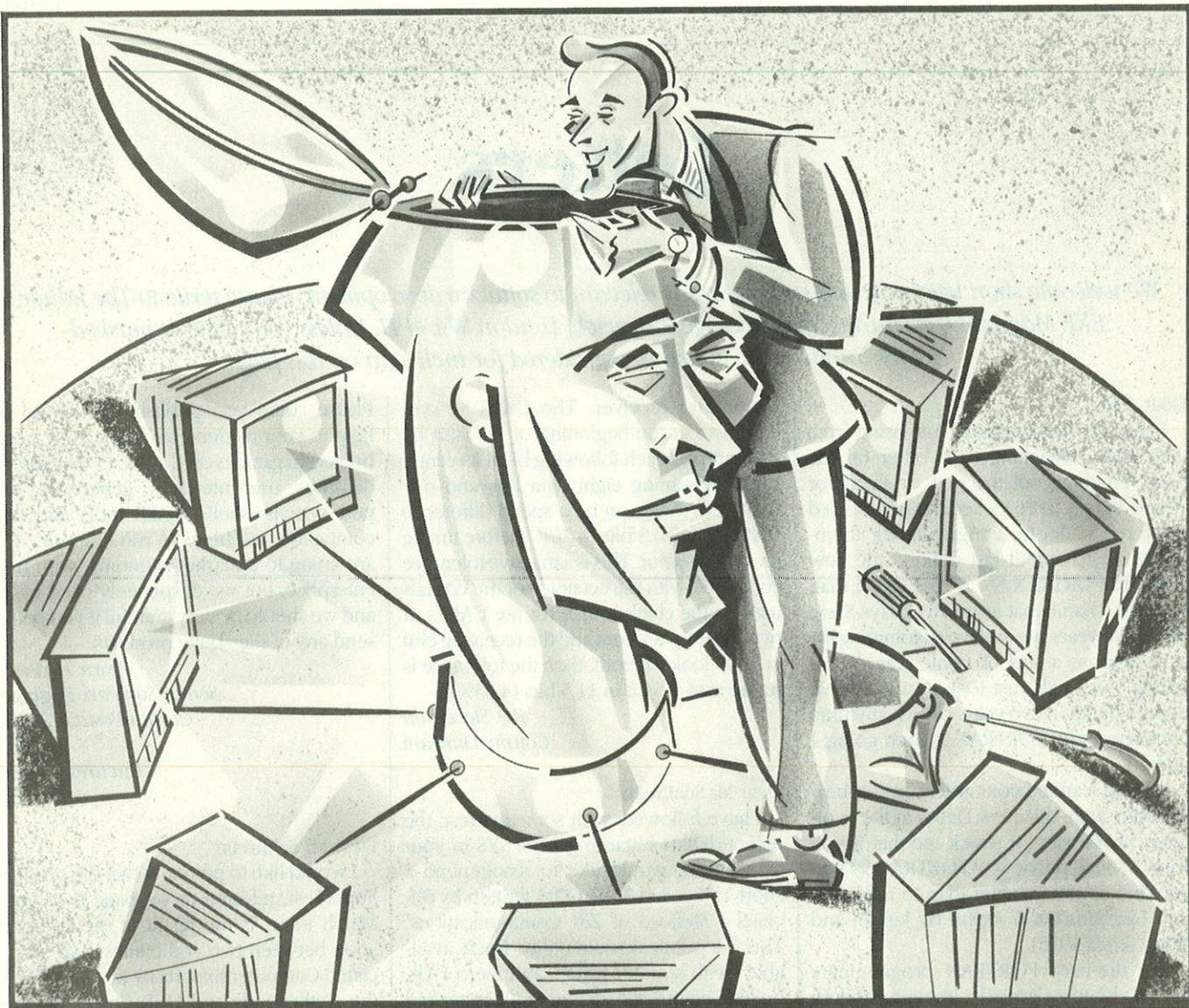
The European Commission proposes to legalise the decompilation of commercial software - this is considered an infringement of copyright in many countries. At a recent conference of leading computer and legal experts, representing all major EC countries, the consensus was that this 'could endanger the development of the industry'.

## Better BASIC

Microsoft's Product Manager for BASIC, Todd Neilson, flew in from the US last month, and .EXE had the chance to talk to him. We asked about BASIC V7.0 (the Professional Development System, which we're hoping to review soon), and about the future for all Microsoft languages. Some of the more important things he told us were:

- The launch of BASIC V7.0 doesn't mean the death of QuickBASIC. QB will continue to be enhanced, using 'hand-me-down' improvements from BASIC PDS. The awkward situation where QB had a number of features that were not present in BASIC V6.0 will not happen again.
- Microsoft is planning a new BASIC product, which will be object-oriented and graphics-based. A command-line switch will allow code generation for Windows or OS/2 Presentation Manager (this high-level way of writing graphical apps will come to all Microsoft languages in time).
- Stub files. Microsoft acknowledges that stub files are no substitute for a well-written library package and intelligent linker. The embedded ISAM system will go multi-user in the next release. Also, the next release of Microsoft's SQL server will include the necessary libraries to allow SQL statements to be embedded in BASIC programs.
- Microsoft acknowledge that big arrays are not really possible under BC7. True, you can now break the 64 KB limit with arrays, but you are still stumped if your array is larger than 128 KB. This will be fixed in a future version.
- Microsoft are looking at ways of making assembly language more accessible from BASIC. Future versions of the language may well have an integrated assembler, as does the latest version of QuickC.
- In QuickBASIC, there are two different code generators. One is invoked when you run a program inside the QB environment, and the other generates .EXE files. In BC7, this is no longer the case. There is only one code generator.





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# Letters

*We welcome short letters on any subject that is relevant to software development. Please write to The Editor, .EXE Magazine, 10 Barley Mow Passage, Chiswick, London W4 4PH. Unless your letter is marked 'Not for Publication', it will be considered for inclusion on this page.*

Dear .EXE,

I can see the committee just rising from their seats, whacking each other on the back, breaking out the port or sherry or whatever they keep locked away in the Red Conference Room, congratulating themselves on having at last defined the new standard FORTRAN 88. A nice touch that; giving it a name that as much as says, 'Hey, we're two years late and we're admitting it!', as I suppose a sort of ironic way of implying; 'well hell, just look at what we've done!' (But then two years late for anything connected with FORTRAN is good going, I guess.)

Having scanned your article on this new breakthrough, this New Dawn in the evolution of software, it struck me that if you want a sneak preview of FORTRAN 99 you couldn't do much better than to read *Pascal: User Manual & Report* by Jensen and Wirth (circa 1976).

But die-hard FORTRAN programmers needn't be too alarmed: although productivity and source maintainability can be improved by the use of languages like Pascal, Modula-2, FORTRAN 99 and so on, it is still possible - with a bit of ingenuity - to create a flowchart-style spaghetti of a program requiring much debugging, and making its creator indispensable to his employer as the guru of the machine (an old GEC mainframe with any luck).

I can't wait to hear what's in store for COBOL...

*Everard Cunion  
IIS Limited  
Langley, Slough*

Dear Sir,

Further to the article 'If I may interrupt' (March '90 issue), I would like to take issue with Mr Margolis's statement concerning the difference in speed between two systems which are communicating with each other via UARTs.

He states that 'any difference in speed between two systems will become cumulative, causing errors'. This is not so, because the UART is, of course, an asynchronous device designed to cope with the slightly different clock speeds between the trans-

mitter and receiver. The UART re-synchronises at the beginning of the start bit and samples each following bit at its centre point. Assuming eight data bits and one parity bit, there can be a speed difference of 0.5 bit in 10.5 bits (4.76%) before timing errors will occur. This is a massive tolerance compared with the accuracy of the crystals used as the clock source for the UARTs. If two stop-bits are sent and the receiving end is set to look for both, then the tolerance is reduced to 0.5 bit in 11.5 bits (4.35%).

*R A Stevenson  
County Durham*

Dear Mr Schifreen,

I have followed, with some interest, the recent debate regarding ANSI.SYS in your magazine. I would like to recommend a short TSR called ANSI.COM written by Michael J Mefford of Ziff Communications. This is a public domain utility, freely available (with source) from a number of UK bulletin boards, which is not only faster and more efficient than ANSI.SYS, but offers a number of significant enhancements. The adjustable key assignment buffer can be cleared or redefined, the ANSI mapping can be enabled or disabled at will, and the whole program can be readily uninstalled. This is an excellent replacement for ANSI.SYS and, to date, I have not heard of any problems with it.

Use of this program solves many of the problems and objections to the conventional ANSI device driver approach.

*Chris Roper  
COGITARE Limited  
Devon*

Dear Sir,

My name is Doru Turturea. I am a Senior Software Engineer at the Research Institute of Computers of Bucharest, which is the capital of Romania. I am also the General Secretary of the Romanian Computer Science Society. We have been able to form this society as a consequence of our People's Revolution.

At the Research Institute for Computers, we lost many valuable books, software packages and machines in the Revolution.

Please could you publish this appeal of help to your readers: we desperately need books, magazines on C and C++ languages, diskettes, user-interfaces, generators, expert systems shells, CASE tools and PC-compatible machines to run them on. We are going to a market economy, with free enterprise, but we desperately need help, and we should be very grateful if you could send any of the above products.

*Doru Turturea  
Senior Software Engineer  
Casuta Postala 2 -122  
Sector 1  
Bucuresti 71200  
Romania*

Dear Mr Schifreen,

I would like to point out that the product SuperTest, referred to on page 6 of your March issue, is the result of the co-operation between two companies: ACE Associated Computer Experts bv of Amsterdam, the Netherlands and HCR Corporation of Toronto, Canada. We would be pleased if you would print a rectification, informing your readers of this joint transatlantic relationship.

*Marco Roodzant  
ACE Associated Computer Experts bv  
Amsterdam, The Netherlands*

Dear Robert,

In his article on formal methods of software development (.EXE Vol 4, Issue 7), Darrel Ince writes: 'Some specialised software tools known as theorem provers have been developed...' Are any of these tools commercially available?

*John Naylor  
Cambridge University Press  
Cambridge*

**Darrel Ince replies:**

*Mr Naylor has identified the Achilles heel of formal methods. The systems that I described currently exist only as prototypes at Manchester University and Imperial College, London. However, there is a commercial Pascal verifier, called the Stanford Pascal Verifier, which is available from Stanford University, US.*

**.EXE**



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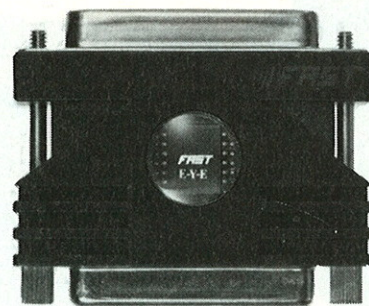
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# FAST

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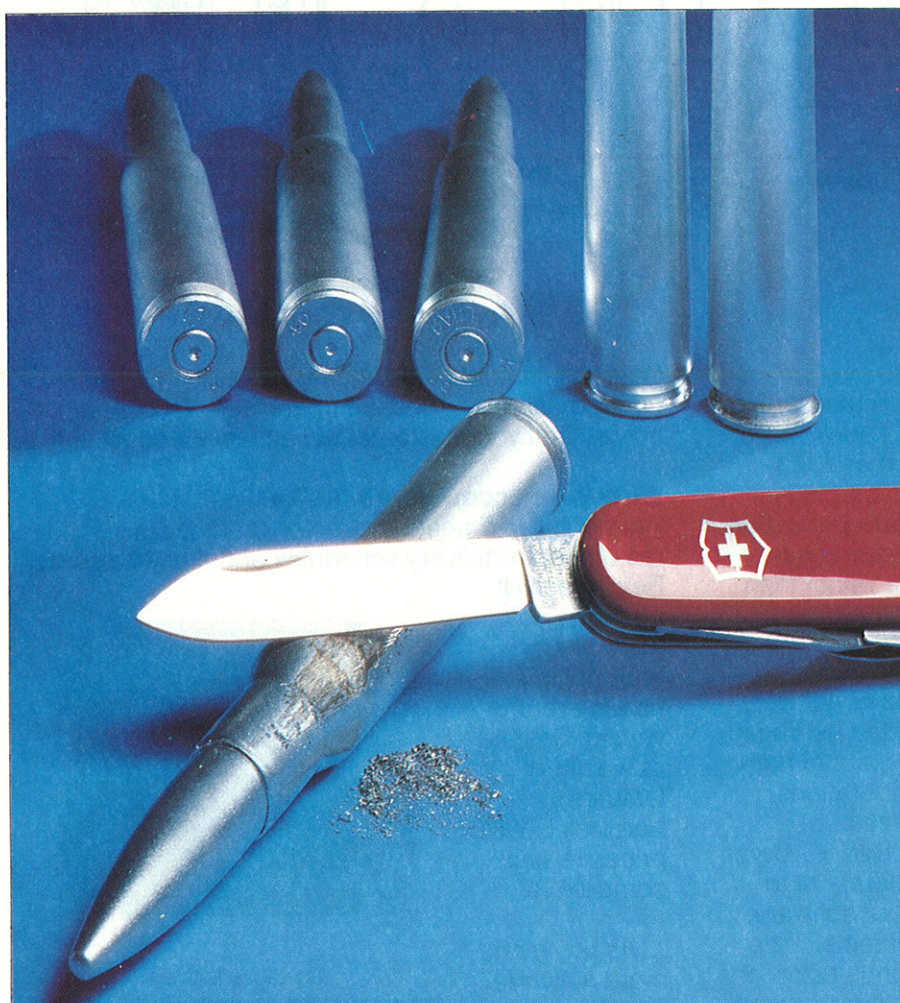
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# OOP meets Modula-2

*The OOP programming solution is being liberally applied to all kinds software.  
Niklaus Wirth dares to doubt the universality of this silver bullet.*



It is a sad fact that our field of Computer Science is overly dominated by fads. These appear in times of acute difficulties, are praised as powerful medicine against the major ills, and are carried by high hopes of all in despair. In the area of software and programming, the often-cited 'software crisis', first openly acknowledged in 1968, made *structured programming* popular. It was an expression of the recognition that complex software can only be understood if it is orderly and structured. The development of huge systems, programmed by armies of 'analysts', made it evident that co-ordination, in the form of documented interface specifications observed by all participating workers, were mandatory. Management became a dominant topic, and all these aspects were somehow covered by the new wave called *software engineering*, implying the claim of professional approach.

The most recent slogan is *object-oriented programming*. It expresses a different view of systems, focused on decentralised control, and oriented in the area of systems programming. Every such trend has its legitimate reasons and goals, and it is appropriate to investigate its usefulness for one's particular objectives. Such a study is necessary in order not to succumb to the negative aspects of a fad: to apply it where inappropriate simply out of fear of being called old-fashioned. It is vital to understand the issues and foundations of a new discipline. Otherwise we will not master the discipline, but be mastered by it.

## What is O-O?

At the core of the object-oriented concept is, I believe, decentralised control. The prime example, which is well-suited to explain the idea, is an operating system. A conventional system contains a central routine, which accepts input from a keyboard and dispatches control to the routine specified for interpretation of the command. An

Professor Niklaus Wirth is one of the most important and influential figures in the field of Computer Science. He began his academic career at the Swiss Federal Institute of Technology (the Eidgenössische Technische Hochschule, usually abbreviated to ETH). He went on to study in Canada and the USA, receiving a PhD from the University of California in 1963. After interludes working at the Navy Electronics Laboratory in San Diego, and teaching at Stanford University, he returned to Switzerland in 1967. Later on, in 1976, he spent a sabbatical year at the

famous Xerox PARC in Palo Alto. He still works at ETH.

Professor Wirth is probably best known for creating a series of programming languages: Euler (1963, his dissertation project), ALGOL W (1966), Pascal (1971), Modula (1975), Modula-2 (1980) and Oberon (1988). Each these languages incorporate certain design principles, such as simplicity and abstraction, which are now generally considered (due, in no small part, to Wirth's efforts) as 'good design'.



Figure 1 - Conventional vs Object-Orientated Terminology

type	class
variable	object, instance
procedure	method
call	message
extension	inheritance

even simpler example is the 'operating system' of a desk calculator, which selects the routine according to the function key pressed. Modern workstations, with their multiple window (viewer) capability, require a more sophisticated approach. Typically, operations are demanded through a mouse click. The action to be taken depends on the position of the displayed cursor. It is initially unknown to the system, and depends on the type of viewer in which the cursor happens to be located. Each viewer is considered to carry its own mode of command interpretation; in short, each is regarded as an *object with its own behaviour*. This scheme is implemented by executing a search for the descriptor representing the viewer designated by the current cursor position, and then by dispatching control to a routine assigned to that descriptor, a so-called *handler*. Naturally, different (types of) views must be able to contain different handlers. Instead of control being centralised in a single dispatcher (in which the identities of the destinations are explicitly specified), control is distributed among the handlers, whose identity and number is not specified in the dispatcher's program text.

Incidentally, this view of a structure, with its own routines for interpreting its data, coincides with the notion of the abstract data type. The type declaration does not only specify the types and structure of data, but also the applicable operators and function. Variables are said to be instances of the type. In the community of object-oriented programmers, the set of objects with identical data structure and handler is called a *class*, and an object is an instance of a class, in the same way that a variable is an instance of a type.

It is often desirable to be able to *derive* a new class. This is where instances of some new class share the properties (ie attributes and operations) of objects of an existing class, but have extra properties. These new instances become special members of the original class and form a subclass. A typical example is given by subclasses of viewers. Text viewers, graphic viewers, picture viewers will share all properties of viewers, but

will also have additional operators suitable for handling texts, graphics or pictures.

Some programmers find it attractive to view computer systems like humans. An object-oriented system is then compared with a human society. A symptom of this anthropomorphic view - which I can find misleading rather than useful - is the notion that a subclass *inherits* the properties of its superclass. Thus the subject of inheritance has found its entry into the programmer's technical jargon. It might be added in passing, that the term 'subject-oriented' would have been more consistent with the popular anthropomorphic view than 'object-oriented'. After all, in the conventional sense, it is the subject that displays a characteristic behaviour and receives messages. The object, on the other hand, plays only a passive role.

It is by no means accidental that the paradigm of object-oriented programming - we bow to convention and adopt the misnomer - originated in the application area of simulation of systems with discrete events. There emerged the need to represent abstractions of agents with properties and behaviour. Such abstractions were first expressed in languages Simula-1 [1] and Simula-67 [2]. The main focus still lay on simulating the collective and concurrent actions of classes of agents, using an interpreter with a single processor. The idea of using processes or, more precisely, coroutines, remained intimately coupled with Simula. The notion of an object was adopted by others, and plays the central theme in the language Smalltalk [4]. However, the paradigm of simulation and quasi-concurrency was dropped - or at least fell into the background.

## An OOP Language?

First, it is worth noting that applications which fit the object-oriented view usually involve a large number of data elements, most of which have a transient existence. The primary requirement to produce such applications is the availability of *dynamic data structures*, often expressed as records accessed by pointers. The necessary mechanisms are dynamic data allocation and (preferably automatic) retrieval.

We can also identify two essential requirements for an object-oriented language:

- It must be possible to define templates (of objects) consisting of variables *and* procedures. Templates were given the name *class*, and instances of class are said to be *objects*. Procedures defined for a class are called *methods*, and invoking a method is called *sending a message*.
- It must be possible to derive new classes from existing classes. A derived class is *related* to its base class (from which it is derived) by the fact that it adopts the latter's variables, adopts/replaces its procedures, and may add new variables and procedures. A derived class is compatible with the deriving class, in the sense that an instance of the derived class can be substituted for any object of the deriving class.

These compatibility rules imply that a procedure of an object may be invoked without reference to its exact identity, because the object may be an instance of many of the derived classes. This explains the use of the term *sending a message* instead of *calling a procedure*. The meaning of the message is known, the interpreting procedure is not. The dispatch of a message can now occur in a place where the actual procedure is unknown, in particular in a module that lies below the module in which the procedure is defined. Hence, such calls also are known under the term *upcall*. Figure 1 shows a comparison of conventional and object-oriented terminology.

We are now in a position to investigate the suitability of Modula [3] for object-oriented programming. The need for dynamic data structures is satisfied (although most implementations do not contain automatic storage retrieval). The first requirement is also satisfied, through the existence of procedure types. Objects can be represented as records, their methods as procedure-typed fields. Sending a message turns out to be an indirect call to a procedure via a procedure-typed variable of this sort.

However, the second requirement is not met. It is impossible to derive a type T1 from

```

TYPE  Point2 = RECORD x, y: INTEGER END
      Point3 = RECORD (Point 2) z: INTEGER END
VAR   p2: Point2; p3: Point3;

p2 := p3    corresponds to    p2.x := p3.x; p2.y := p3.y

```

Figure 2 - Deriving 3D type from 2D type



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a type T0 such that T0 remains compatible with T1 (apart from the trivial cases of identity and subranges).

We could leave the topic at this point. However, it is worth investigating whether an object-oriented style might be used, if certain safety properties of Modula are sacrificed. As was pointed out in [9], a possible approach lies in using the special features contained in the module SYSTEM; in particular, the ADDRESS type offers a solution. (*Modula's ADDRESS type is a generic pointer type, similar to C's void \* type - Ed.*) In anticipation of the need derived types, the declaration of the basic type is provided with an additional field, say `ext`, of type ADDRESS. It is then possible to produce derived objects, by assigning to `ext` a pointer to a record type containing the extra variables and procedures.

Leaving aside the question of the additional indirection in accessing the new fields, the crucial drawback to this approach is that the compiler's type checking capability has been crippled. A program using this recipe is potentially as unsafe as assembler code. Type safety should be the last property of a high-level language that we are willing to sacrifice. The low-level facilities in Modula-2 were provided with the intent that they be used sparingly, in cases where access to special machine resources are needed, and that they be isolated in small driver modules. I caution against their instalment as central instruments to be used throughout entire programs.

What we must do, from the point of view of language design, is find a solution which is neither a fix nor a trick, but which properly integrates the new requirement with the existing properties, and fully complies with the concept of type validation through textual inspection (viz compile-time checking).

## Extending Modula-2

Our approach to adapting Modula-2 for object-oriented programming lies in extending the language with features that fit

into the existing framework, allowing a precise and concise definition based on well-understood mathematical concepts. If we

## *Fads appear in times of acute difficulties, and are praised as medicine against the major ills*

concentrate on the fundamental requirements, only a single new facility is actually called for: the one for introducing derived classes of objects.

In accordance with the basic principle of introducing as few concepts as possible, and recognising the strong similarity between types and classes, we equate the term 'object' with 'instance' (of a record type) and 'class' with 'type'. A derived class (subclass) then corresponds to an *extension* of a record type [5]. To take a geometric analogy, if a record type is defined to represent a point in *n*-dimensional space, with each dimension represented by a field of the record, an extension - adding extra fields - increases the dimensionality of the space. An assignment of an instance of a derived class (ie a variable of an extended type) to an instance of its superclass (ie to a variable of the base type) corresponds to a *projection* of the variable's value onto the subspace spanned by the base type. Figure 2 gives an example of this, using two-dimensional space for the base type (Point2) and three-dimensional space for the derived type (Point3).

The concept of extension is also applied to pointer types, so it becomes possible to construct heterogeneous structures, whose relating pointer type is bound to a node

type R. The nodes of the structure may then be of different extensions of R, say R1, R2 and R3. Clearly, a need for determining the actual (extended) type of a node referenced by a pointer (bound to R) arises. Oberon, a Modula-2 based object-oriented language, provides it in the form of a *type test*, implemented as a Boolean factor with the operator IS.

We emphasise that the principal achievement of Oberon [6,7] is that the concepts of types and classes were *united*. The coexistence of two distinct notions, representing virtually the same concept, was avoided.

## Syntax

Some more should be said regarding the representation of methods through procedure-typed record fields. In object-oriented languages, a class declaration looks just like a record declaration, with procedure declarations (or at least procedure headings) tagged on. This approach has consequences and some advantages. In Modula and Oberon, the corresponding procedure-typed field assumes the role of a variable. Hence the actual procedure must be assigned to it explicitly, each time an instance of the record is generated. This can be regarded either as a burden (and a source of mistakes) or as an additional degree of freedom (and power). Yet most typical applications bind the *same* procedure (handler) to all instances of a class: the view of methods is *class-centred*. Oberon's view is *instance-centred*. Figure 3 illustrates this contrast.

In an implementation of the class-centred view, each instance will contain a hidden pointer to the same table of procedure references. In an Oberon implementation, each instance contains direct (and duplicated) references to the installed procedures. This is clearly undesirable, if there are many of them.

Another advantage of the class-centred view, and of declaring procedure bodies within the class declaration, is the possibility of referring directly to the object fields (*x*, *y*, *w* and *h* in Figure 3) from within the procedure. This leads to a convenient formulation of sending the message `restore` to the object *v*:

```
v.restore(T)
```

This form is entirely consistent with the notation for field designators such as *v.x*. In the above call, *v* plays a double role as *distinguished parameter*. It qualifies the method name (via the class of *v*), and it represents a parameter of the call, namely

<pre>CLASS Viewers =   BEGIN x, y, w, h: INTEGER;   METHOD restore (T: Text)     BEGIN ...   END restore END</pre>	<pre>TYPE Viewers =   RECORD c, y, w, h: INTEGER;   restore:PROCEDURE (T:Text)   END</pre>
<pre>v := Viewers.New (X, Y, W, H)</pre>	<pre>NEW(v); v.x := X; v.y := Y; v.w := W; v.h := H; v.restore := Restore</pre>

Figure 3 - Class-centred versus instance-centred syntax



the variable *v*. In Oberon, this abbreviating form is not possible, and the two roles are clearly disjoint:

```
v.restore(v, T)
```

The distinction between class- and instance-centred view with regard to method definitions can be viewed in another way. In the former case, methods are declared as procedure-typed *constants*, in the latter as procedure-typed variables. The restrictiveness of the class-centred approach becomes apparent when one considers subclasses (type extensions). Usually, a subclass contains methods different from those of its superclass. As they are declared as constants, a new language 'feature' is required: the ability to *override* the definition of the superclass. In class-centred implementations, overriding is achieved by the provision of a distinct method table for each subclass. In the instance-centred view, adopted by Oberon, no such additional mechanism is necessary. Nor has the additional notion of overriding any place, as it occurs through a regular, explicit assignment.

A class-centred derivative of Oberon has recently been devised and implemented [10]. It showed that the additional complexity of the compiler remains within tolerable bounds. The unanswered question is rather whether the notational conveniences justify the *conceptual* complications.

Object-oriented languages typically confine objects to be dynamically allocated records, which are referenced via pointers. In Oberon, such a restriction would have to be defined through an explicit, exceptional rule. As it stands, the language permits both dynamic *and* static variables of a record type; these variables are, therefore, extensible. In practice, the type extension concept turned out to be extremely useful in the case of static variables passed as reference parameters to procedures. If only dynamically-allocated records were permitted, the consequence would be the use of dynamic allocation when, conceptually, a variable should be declared as static and local, because of its transitory nature. This, in turn, may have grave consequences on the efficiency of an implementation. Oberon's generality turns out to be a significant benefit. Treating every variable as an object is a mistake.

## Conclusions

Apart from convenient syntactic constructs, an object-oriented language features declarations of procedures bound to data structures (records), and offers the possibility to

declare structures (extensions) that are derived from other structures and are type-compatible with them.

In Modula-2, it is possible to adopt the object-oriented paradigm, by resorting to

## Almost the entire operating system was better programmed without OOP

low-level facilities and sacrificing the most important asset of a high-level language: the guarantee of type consistency.

The language Oberon extends Modula-2 with the necessary facility: *type extensions*. There exist, however, some differences between Oberon's object-oriented facilities and those of other object-oriented languages. The most important of these is that in conventional object-oriented languages, procedures/methods appear as constants in the declaration of the record type/class. In Oberon, they appear as variables (record fields). In the first case, methods are guaranteed to be the same for all instances of a class. Oberon's methods may differ from instance to instance, and need to be explicitly installed whenever an instance is generated. With the typical object-oriented languages, the redefinition of methods (installed as constants) requires the additional concept of overriding. No such facility is needed in Oberon.

As a result, Oberon is conceptually simpler, and Oberon implementations are not burdened with additional class mechanisms. On the other hand, other object-oriented languages may offer somewhat more convenient notational facilities, and provide extra security by guaranteeing the constancy of declared methods for all instances of a class. This results in improved efficiency of upcalls. We consider this as a negligible advantage, since we believe that the object-oriented paradigm should be employed very selectively. In the design of an entire operating system [8], we found that almost the whole system was advantageously programmed in the conventional style. The object-oriented style was restricted to the viewer system, which provides distributed control. It is wise to use upcalls sparingly.

A much more significant contribution to efficiency is the generalisation of the type extension (subclass) concept to static variables, and in particular in their use as procedure parameters.

The most significant aspect of Oberon is that it supports both object-oriented programming and the conventional style, and that it guarantees full type-consistency checking. Oberon differs from other languages, because of an underlying conviction about language design: one should strive for simplification, through integration of similar concepts, rather than for complication through the addition of new facilities, similar to those which already exist.

*This article was first presented as a paper at the First International Conference on Modula-2, Bled, Yugoslavia, Oct. 11-13, 1989. Many thanks to the Josef Stefan Institute, Yugoslavia, and to Professor Wirth himself, for permission to reprint it. Complete copies of the conference proceedings, priced £20, are available from: Modula-2 (E-4), J Stefan Institute, Jamova 39, 61111 Ljubljana, Yugoslavia. Phone 010 38 61 214 399.*

EXE

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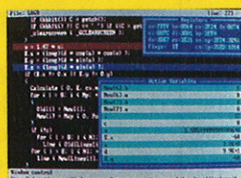
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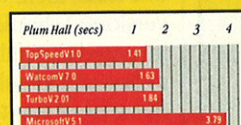
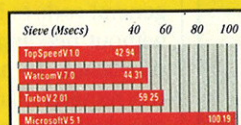


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# History of a Useful Illusion

*Who said history could never be objective? Richard Drake tells the tale of a technology born in obscurity in the 1960s, and acclaimed as the great hope for the 1990s.*

It could only have been created by a man who knew what it felt like to be a CPU. Shortly after the war, the Norwegian government, which was struggling to set up a nuclear power industry, needed a digital computer to perform some complex and repetitive computations. Of course, there was no cash for such a machine, so instead the Norwegians filled a room with soldiers, including one Private Kristen Nygaard (sounds like 'knee-guard'), and kept them there for several weeks, simulating the calculations of the inaffordable machine. This experience must have rankled, because many years later Kristen Nygaard, with his colleague, one Ole Dahl, turned the tables on the electronic CPU by designing two successive computer languages that allowed effective simulations to be programmed on it.

The first of these was Simula I, an extension of Algol 60, which introduced the concept of an 'activity' or process description. By the middle of the 1960s, Nygaard and Dahl felt they had identified a number of key points through their work with this language. In particular:

- The distinction between a piece of program text and an execution, or a 'dynamic instance' of it.

- Data and operations belong together, and most useful program constructions contain both.

- Processes often share a number of common properties, both data and actions, whose declarations should not have to be repeated.

- A garbage collection scheme is required for removing dynamically created processes that are no longer needed.

The last idea was borrowed in part from LISP world - the first of a number of ways in which LISP was to influence the direction of OOP. These concepts paved the way for an event that is widely recognised as the birth of object-oriented programming.

## Born in Obscurity

In 1967, Nygaard and Dahl created Simula 67 (actually the final definition was, like most software babies, delivered late, in May 1968). Simula 67 was a general purpose programming language, later to become famous as the first object-oriented programming language.

If this was the birth of OOP, its conception can probably be traced to a wintry Nor-

wegian day in December 1966, when the solution to the problem of repeated definitions of 'common properties' was finally drafted. By this time, Nygaard and Dahl had renamed activities 'classes', and had begun to ponder how common properties might be grouped together in a class from which other 'subclasses' could be derived. After careful thought, they arrived at an open syntax for subclasses (contrasting with Pascal's closed syntax for variant records) that would allow the extension of an existing class, without any need for modification of the original source code.

The problem used to illustrate subclassing was the simulation of a toll booth on a bridge with a queue of vehicles that may be either cars or trucks. A sketch of the solution, using the class `Link` as the basis for a linked list of vehicles, is shown in Figure 1. The advantage of this approach is that if, later on, the program needs to be extended to cope with buses, none of the existing code for `Vehicle` need be changed. Thus it became natural to construct hierarchies of classes in Simula 67, a key feature of object-oriented programming to this day.

Subclassing led to further language changes, including relaxing compatibility rules so that, for example, references to instances of `Car` or `Truck` could be assigned to variables declared as `Vehicle`, allowing general code to handle a queue of vehicles without needing to know all the possible subclasses. In addition, where an action was required that was defined in more than one class, there was a need to resolve which version(s) should be used. A construct was invented to combine procedures defined in a class and its subclass, and the principle of dynamic or run-time binding of procedures was established, to let general code specify the appropriate action (such as travel at average speed) without necessarily know-

```
class Link; ...definition of data and actions... ;
Link class Vehicle; ... ; (Vehicle defined as subclass of Link)
Vehicle class Car; ... ; (Car defined as subclass of Vehicle)
Vehicle class Truck; ... ; (Truck defined as subclass of Vehicle)
```

Later on, the program can be extended to cope with buses, without altering the code for `Vehicle`:

```
Vehicle class Bus; ...data and actions specific to Bus here...;
```

*Figure 1 - Vehicle subclassing example*



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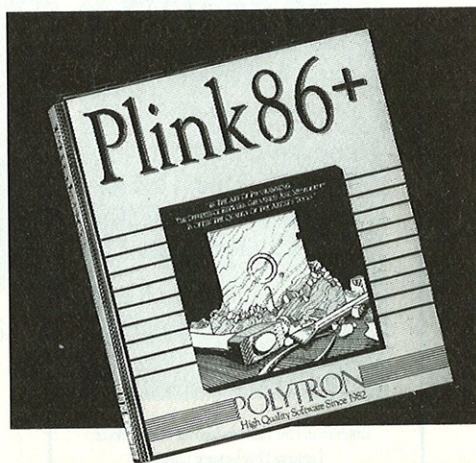
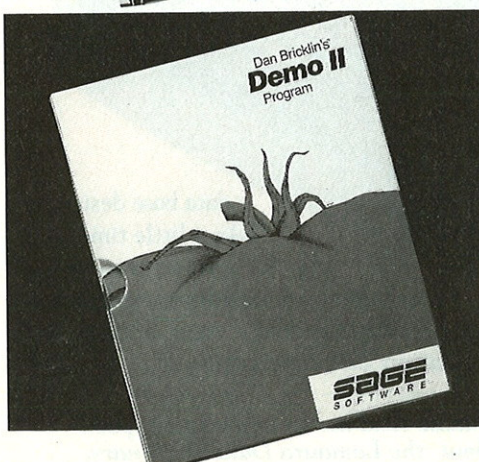
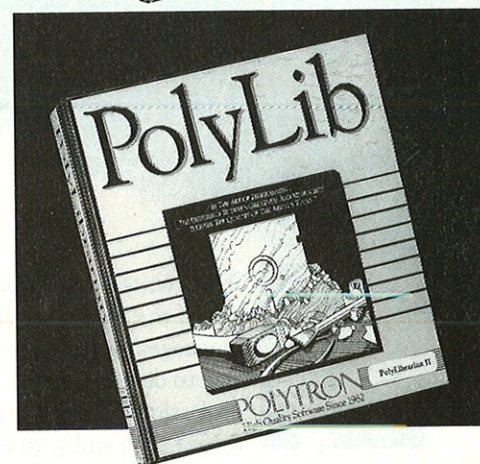
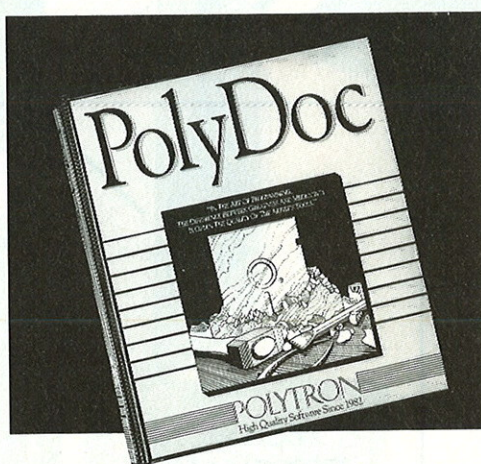
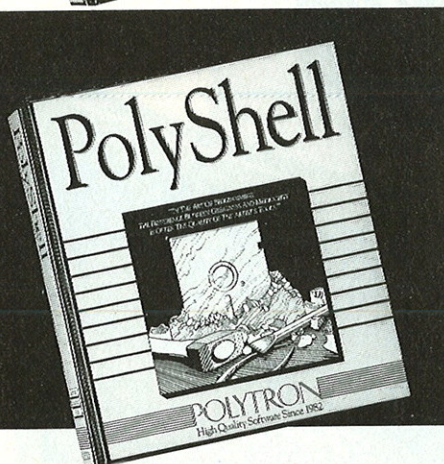
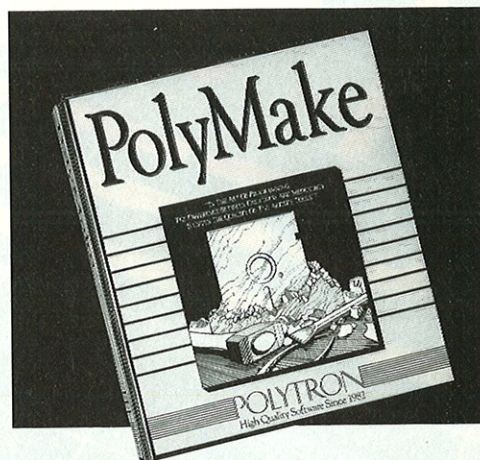
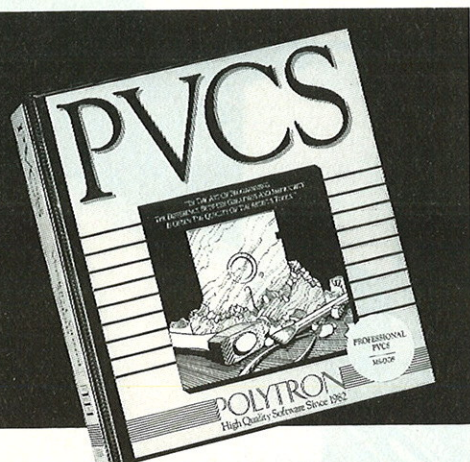
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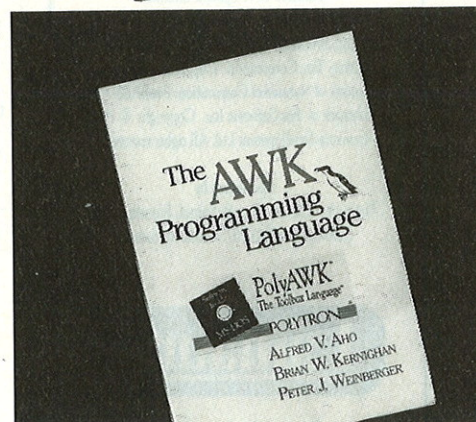


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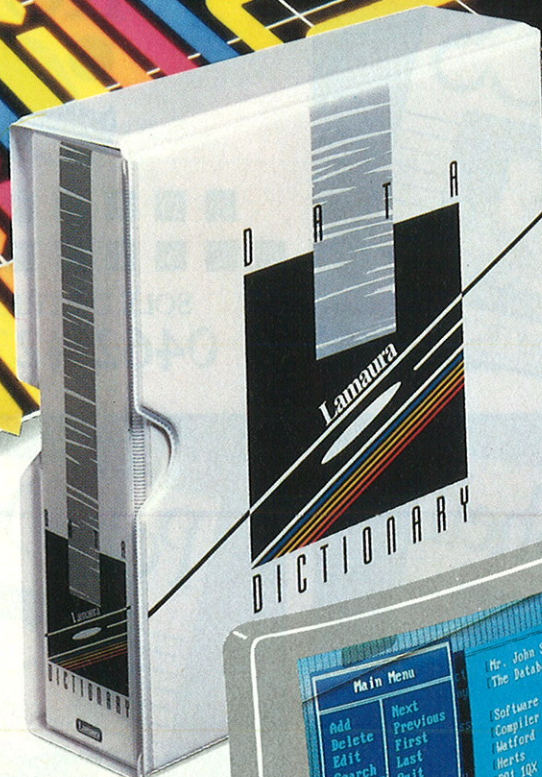
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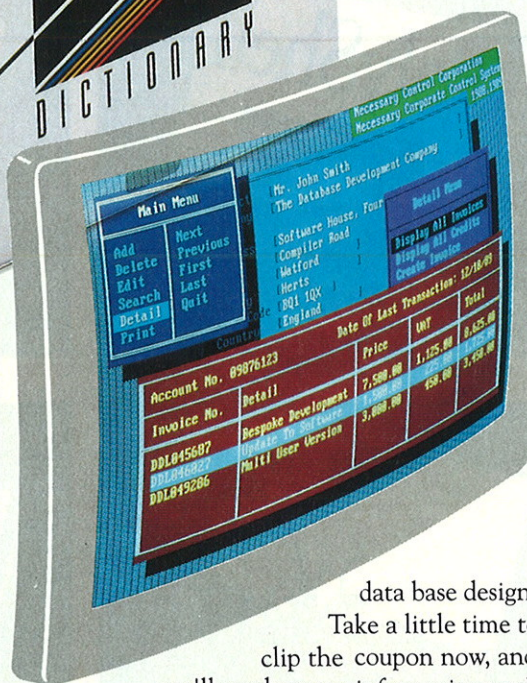
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ing exactly which class(es) would be involved at run-time.

Like any new baby, object-oriented programming needed a name. In Spring 1967 the term 'object' was first coined, as a more neutral term than 'process' for the instance of a class. Little did the creators guess that such a trivial change would have such a dramatic effect on software marketing over twenty years later, as desperate attempts to draft and trademark the latest FOOLish anachronism or OBJECTionable product name fill the waking hours of copywriters and lawyers, all to sell software products that are frequently inferior to Simula 67.

How has OOP gone from obscurity (ie not being invented in America or mass-produced in Japan) to become the software superstar of the 1990s? Well, if you can't be born in the USA, the next best thing is to be adopted there. This is what happened to OOP in an all-American research lab in the 1970s...

## A Secluded Childhood

Around 1970, a young jazz musician, and sometime student at the University of Utah, was introduced both to Simula 67 and Ivan Sutherland's innovative 'Sketchpad' program, which used both a bitmap display and a pointing device. He argued that a combination of the inherently powerful concepts in Simula and the user interface of Sketchpad should be used to create a 'reactive engine', a software language and environment that would be far easier to learn and use than other development systems, and could form the basis for a hand-held personal computer called the 'dynabook'.

Alan Kay didn't get everything right about the future of personal computers (he just missed some minor points, like the fact that a computer as primitive as the Apple II could attract a reasonable market by 1980...). But in the days of mainframes, batch programs and punched-card input, his vision was recognised and backed by the newly-formed Xerox Palo Alto Research Centre (PARC), where he set up the Learning Research Group, with the aim of creating a software system easy enough to be used and 'programmed' by children.

Kay's vision included a language, Smalltalk, which would be uniformly object-oriented - that is, all program entities, including numbers and strings, would be instances of classes, ie objects. In order to emphasise the uniform computational model of the system, the term 'sending a message' was used to describe the calling of action belonging to an object. This became the only

way anything in the system got done. For example, the syntax '3 + 4' was shorthand for sending the message '+' to object '3' with parameter '4'. The code within a class which implemented the message was called a 'method'.

Kay carried out studies of the way children learned to use the system. The feedback from these experiments influenced the way that the user interface of Smalltalk developed. Kay used the term 'user illusion' to describe how objects should be represented on the screen, and originated the

---

***It could only have  
been created by a  
man who knew  
what it felt like to  
be a CPU***

---

metaphor of overlapping windows and pop-up menus. Larry Tesler (who joined Apple in 1981 to help create the Lisa/Macintosh) introduced the complementary ideas of modeless operation, object/verb editing and powerful online browsing facilities for existing source code. Dan Ingalls added a debugger which, even today, shames most of the competition. Other members of the team, which included leading computer scientists like Adele Goldberg and Peter Deutsch, implemented integrated text editing and fast incremental compilation. By 1980, they had created what was the most powerful programming language environment of its time - a position Smalltalk arguably retains today.

In keeping with the conceptual simplicity and the interactive nature of Smalltalk development, the language does not require the class or type of variables to be declared, as in Simula. All objects, except those belonging to 'primitive' classes such as Boolean or SmallInteger, are created dynamically as required. These are accessed through double-indirected pointers, and garbage-collected by the environment when they are no longer referenced. The programmer has no worries over memory management... but, there again, he has no control over it either, as inveterate C programmers lament. Rather confusingly to Smalltalk novices, classes themselves are objects; instances are created by sending the message new to the class in question. Subclasses automatically inherit data fields

('instance variables') and methods from their 'superclasses'. The environment supports various incremental changes to classes, including adding or removing instance variables, even when the classes have existing instances.

Since 1978, most Smalltalk implementations have used a virtual machine model, to maximise portability. The system is similar to the Pascal p-code approach. Source code is compiled into intermediate 'byte-codes', and these are interpreted at run-time. In the last few years, there have appeared implementations which generate native machine code. Consequently the performance of Smalltalk object code, although inferior to that produced by optimising C compilers, has improved steadily. Run-time errors are painless. A new window, called a notifier, appears to report the error - the most common being: sending a message to an object that doesn't 'understand' it. The debugger can be activated directly from the notifier. Very often the source code can be debugged, and the process resumed, without losing results of the execution so far.

## Socialising

In the last decade, the happy picture of steady development, leading to the uniformity and productivity of Smalltalk, is spoilt. OOP experimented with new things, mixed with all the wrong people and, like most teenagers, got in a real mess. But it also learnt a lot; in particular it learnt to relate to real-world software developers, and how they build (and fail to build) commercial systems. Slowly OOP began to influence fundamentally the way systems are put together, a trend that looks set to continue in the immediate future.

Even in the 1970s, object-oriented dialects of LISP had begun to emerge. Flavors and LOOPS are the best known products from this period. Subsequently, adding objects to any and all languages became high fashion, with more or less pleasing results. In my view, 'adding objects' has no real validity unless the resulting language supports at least three things:

- Encapsulation (data and functions/procedures/methods defined together) to create classes (object types in Object Pascal, structs or classes in C++).
- Inheritance of data and functions/methods from super (or base) classes by sub (or derived) classes (C++ terms in brackets, forget Object Pascal!).
- Dynamic or run-time binding, where the result of sending a message/invoking a



Figure 2 - CLOS Multi-Methods

```
;Generic function install
(defgeneric install (software-product operating-system)
  (:documentation "Installs software on the operating system."))

;Method 1 - when both arguments are valid
(defmethod install ((sw basic-product) (os basic-os))
  ;body of method goes here
  )

;Method 2 - if install is called with an invalid OS argument
(defmethod install ((sw basic-product) non-os)
  (error "Cannot install because ~A is not
    a recognised operating system." non-os))

;Method 3 - if install is called with an invalid product argument
(defmethod install (non-product (os basic-os))
  (error "Cannot install because ~A is not a
    recognised software product." non-product))

;Method 4 - both arguments invalid
(defmethod install (non-product non-os)
  (error "Cannot install because ~A is not a
    recognised software product and ~A is not
    a recognised operating system."
    non-product non-os))
```

function depends on the class of the object involved at run time (automatic in Smalltalk and most OOP languages - specified by virtual functions in C++).

Did anybody notice an exponential increase in the complexity of the jargon? This was the first (inevitable) result of letting the unwashed masses get hold of a neat, uniform idea like OOP in Smalltalk.

Objective C, from Stepstone Inc, was the first on the C-with-objects bandwagon. It added a Smalltalk-like message sending syntax to C, but let the language do its own thing with integers and characters. The mismatch between 'objects' and these more elementary data types proved aggravating, but not fatal. With a useful library of basic classes, Objective C was later on adopted as the main development language for Steve Jobs' NextStep environment on the NeXT cube.

Meanwhile, Bjarne Stroustrup extended C into C++. Because he was careful to stay as close as possible to C, and because he worked for AT&T Bell Labs (a slightly unfair advantage, some might say) C++ looks set to become the standard for OOP, just as C became the standard for conventional programming. Unfortunately, C++ is, at present, several times worse than Smalltalk for creating *really* general purpose class libraries, although it is more memory and processor efficient. It has no automatic garbage collection, no way of creating

general purpose collection classes (because of its strong typing and lack of parameterised types), objects have no knowledge of their class at run-time and classes are not themselves objects.

Even with an environment like Objectworks for C++, or a cheap and cheerful one, such as supplied by Zortech on the PC, the lack of a rich class library for C++ (caused partly by deficiencies in the language) means at present that C++ programmers cannot get a feel for the full potential of OOP. Parameterised types should make a difference here, and are promised by Stroustrup some time soon...

In the same vein as AT&T, Apple decided to add objects to Pascal (with a little help from Niklaus Wirth, the inventor of the language) to create Object Pascal. Recently Microsoft and Borland claimed to have released versions of the same language. (Closer analysis by Paul Smith, in .EXE Magazine Sept-Oct '89, suggested that Microsoft implemented the correct language badly, and Borland invented its own language, and implemented it quite well.) Apple, at least, under the guiding hand of Tesler (and now Kay and Ingalls too), provide a decent set of classes. MacApp (as the Macintosh class library is known) supports the Macintosh user interface, and thus does give novices a reasonable amount of OOP for their money. Object Pascal suffers from some of the same problems as C extensions; there is an uneasy cohabitation of Pascal's

data types alongside the new object types.

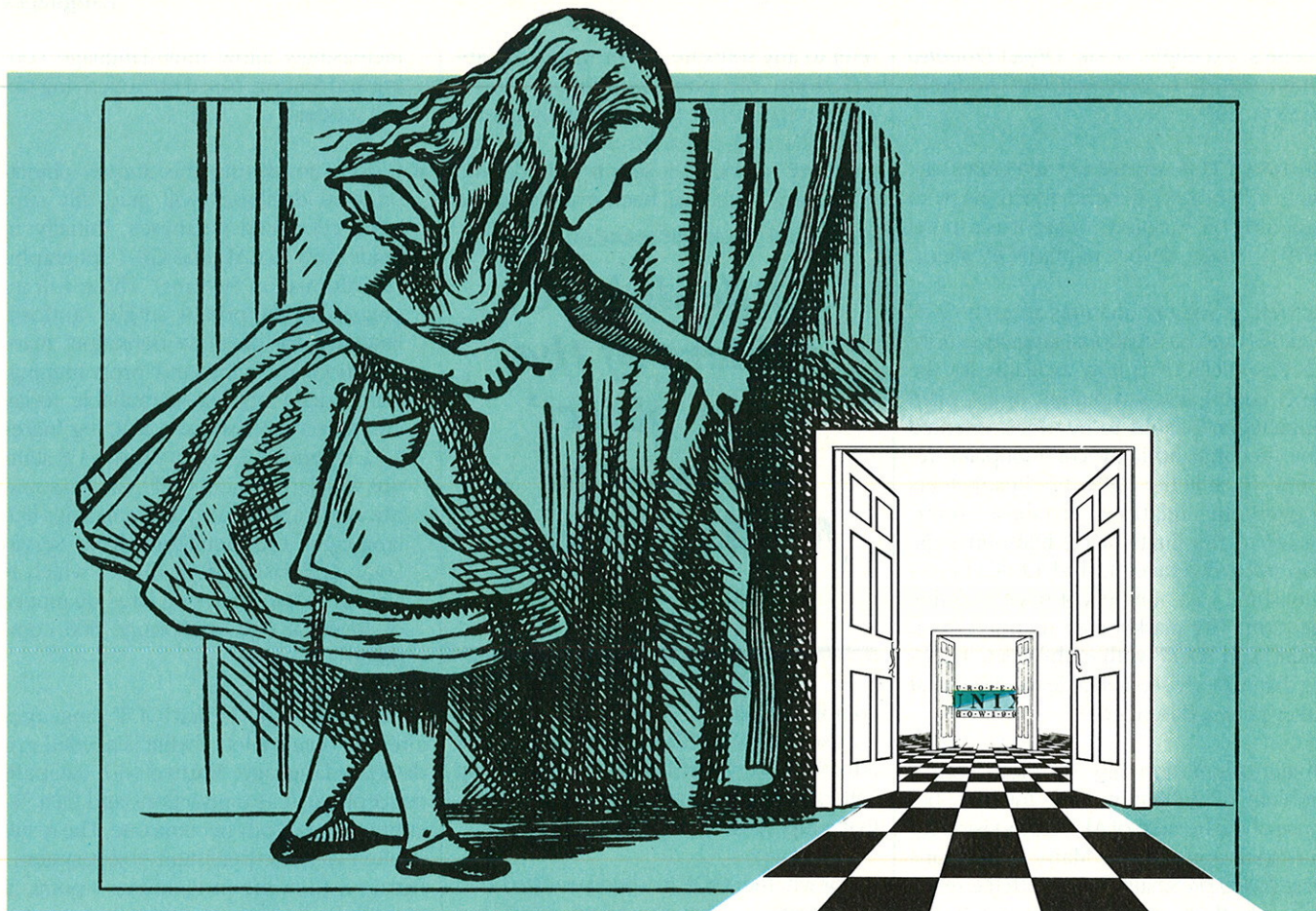
As far as pure OOP languages are concerned, there are three of reasonable commercial significance. Smalltalk exists in two dialects - 80 and V - which are identical, more or less, in their syntax, but differ in their class libraries. Objectworks for Smalltalk-80 is the original system, produced and 'ruggedised' by ParcPlace. This runs on almost any brand of workstation, not to mention the Macintosh and 386 class PCs. It remains the most complete OOP environment but suffers at present from supporting only its own 'old-fashioned' windowing system (it was the first, after all). On the other hand, its portability means that applications written in it can be ported between platforms in a matter of minutes. I can testify the truth of this from first hand experience, having last year moved a large system back and forth between Macintoshes and Apollos for a UK clearing bank.

Smalltalk/V, from Digitalk, runs under MS-DOS, OS/2 PM and the Mac, and supports the native windowing in the last two environments. Although it does not have all the richness of 80's development environment, it has enough to give a good flavour of life in the OOP fast lane at a competitive price. It is also the proud owner of a native code compiler for OS/2 PM.

The two other OOPs of note are Eiffel and CLOS, the Common LISP Object System. Eiffel is Bertrand Meyer's elegant language, designed with modern techniques of software engineering in mind. It includes class assertions, post and pre-conditions and clean error-handling for messages. Both Eiffel and CLOS (and, incidentally, V2.0 of C++) support multiple inheritance, in which a subclass can inherit from more than one parent class. Proponents of Eiffel, in particular, claim that this facility represents a major improvement in the expressive power of an OOP language.

CLOS also introduces a more general and powerful mechanism for selecting the method executed at run-time for a given message, called multi-methods. A CLOS generic function (message) with more than one parameter invokes a method based on the classes of all the parameters, not just the first (the first traditionally being the object to which the message is 'sent' in other OOPs). So the generic function `install`, for example, which installs a new software product on an operating system, will invoke a method depending on the class both of the first parameter (the product) and the second (the operating system). See Figure 2 for a simple application of this; the example is taken from Sonya





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**CIRCLE NO. 890**



Keene's excellent book *Object-Oriented Programming in Common Lisp* (Addison-Wesley, 1989).

Because CLOS seamlessly integrates dynamically-bound generic functions with standard LISP functions, I class it as a 'pure' OOP language, despite its pre-OOP origins.

As well as sincere attempts to graft OOP facilities onto conventional languages (Objective FORTRAN is now available for the NeXT cube!), less scrupulous, or just plain unintelligent, claims to be object-oriented have become boringly commonplace recently. Back in the 1980s, tired marketers flogged the 'relational database' buzzphrase to the limits of credulity until the man who invented it, Ted Codd, began publishing vast numbers of rules to define the term. The market-men then fell upon 'CASE' and 'OOP' with enthusiasm, realising that nobody seemed able to agree what either phrase described.

Object-orientation has suffered from a problem of definition since the 70s, because of the breadth of Alan Kay's vision for personal computing. Many definitions were based on Smalltalk-80, with the result that only those systems sharing selected user interface, design or language features with Smalltalk were object-oriented. Such an approach has dangers, but most experts agree that there are three essential mechanisms, as mentioned already, for any OOP language, which are common to languages described in this article:

1. Encapsulation (classes).
2. Inheritance (subclassing).
3. Polymorphism (dynamic binding).

OOP, so defined, is now 23, older and wiser because of the rough and tumble of the past decade. Everyone agrees it's high time it settled down and began to earn an honest living so that we can see what it really does have to offer...

## Adulthood

Not surprisingly, given the amount of media and marketing copy given to OOP, it has its detractors and debunkers. How come something so good has been around for 23 years and *still* doesn't seem to have been used for any very major software systems? In any case, the whole thing is an illusion - you can get just the same effect in good old C, Modula-2 or Ada.

I would agree on the last point - in fact, the phrase 'user illusion' could legitimately

refer to any software. All programs are abstractions; the poor old silicon has no knowledge of the the elaborately-named variables and procedures that the programmer writes, all it sees is a third hand translation which has been mauled by the

## *Little did the coiners of the team 'object' guess what foolish abuses would follow*

compiler, linker etc. The question is: what is a useful illusion? The main claim for OOP is that it is a very useful metaphor for writing software systems, and there are languages that support the metaphor well.

As for whether OOP has been used to build large systems, I have to admit: some, but not many. However, all the signs are that this is changing.

OOP, in maturing, has three needs: standards for languages and class libraries, the ability to 'live in' and work with existing hardware/software and, most significantly, a happy and stable marriage with the 'other side' of software technology, the database.

As Sam Goldwyn said, prediction is hard, especially when you're dealing with the future. But three trends are already noticeable and can be expected to increase in the 90s:

- *De facto* standardisation, as a few OOP languages are used a lot and the others are marginalised. C++ looks certain to figure as will, I dare suggest, Smalltalk and perhaps CLOS and Eiffel. Meanwhile, standard class libraries, such as those provided with Smalltalk, or NextStep, will become established, and will be usable from multiple languages (NeXT are pioneering here and the Object Management Group is also worth watching).
- Linked with this standardisation will be: support for all hardware platforms, 'calability' to and from conventional code and full support for look and feel standards such as PM, Mac, Motif and Open Look. Development environments will

increasingly allow multi-language coding and linking, based on underlying object models.

- Closely impacting the above, object-oriented databases will gradually supplant relational databases, initially in fields such as CAD and GIS (Geographical Information Systems). These will increasingly support a single, uniform language for database definition, manipulation, querying and programming. Three main options identifiable today are: object extensions to SQL (eg Ingres 6.3), extended C++ (eg various US start-ups with large amounts of cash and sophisticated vapourware) and Smalltalk-like languages (eg GemStone from Servio Logic and Vision from Insyte, which is already in use analysing large quantities of financial data in Fortune 500 companies).

What's significant is that OOP languages already contain a lot of what is needed in a database language. Married with database concepts such as transactions and data security, they happily become one. The result is often called a 'persistent object system', because, from the programmer's point of view, little changes, except for the convenient fact that the objects you are dealing with persist after the program has ended, and so can be shared with other programs.

As persistent object systems, built from standard OOP languages such as C++ and Smalltalk, become widely available, OOP will have become a mature adult that will surely transform the software world. The next ten years will decide.

Postscript: sincere apologies to the 'parents' of OOP, Kristen Nygaard, Ole Dahl and their colleagues, for ignoring their significant work in applying Simula 67 and, more recently, in developing Beta, an innovative multi-paradigm language. I hope that the distinctive insights of the 'Scandinavian school' can be translated into globally successful OOP products in the 1990s, allowing the wider software community to benefit from the oldest and, arguably, the wisest body of experience available worldwide in building industrial-strength systems using objects.

EXE

*Richard Drake is Managing Director of Objective Computer Systems, a London-based consultancy specialising in object-oriented and database applications, including GIS and financial systems. He was one of the organisers of the third European Conference on Object Oriented Programming (ECOOP 89) last July.*



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**CIRCLE NO. 891**



# The Tamer Transputer

*David Gristwood looks at two ways of harnessing the power of a network transputers, using the C programming language.*

To date, parallel processing has had very little impact on the IBM PC community. Yet the PC, with its open architecture, is the ideal host for plug-in parallel processor cards. Several such processors are available, one of the most popular being the Inmos transputer. In this article, I will explore some of the ways in which a network of transputers can offer increased processing power, using two different C compiler systems: 3L's Parallel C, and Helios.

To recap: the transputer is a RISC-like (Reduced Instruction Set Computer) processor with its own local memory and links for connecting to other transputers. The T800 series transputers have on-board floating point units, and are capable of an impressive 10 MIPS and 1.5 MFLOPS at 20 MHz. Each transputer has between 2 KB and 4 KB of internal RAM, mapped into the standard address space. The links, typically four per transputer, allow rapid inter-processor data transfer, and can operate at up to 20 Mbits/sec. Each link has its own controller, enabling the links to work in parallel with each other and the CPU.

The transputer's model of parallelism is based around the process. This is the basic building block for all systems. Programs are designed in terms of interconnecting sets of

processes, which communicate along synchronised point-to-point channels. These channels are the 'outside' interface to the process, so that its internal design remains hidden.

The transputer provides a number of special operations to support this process model, eliminating the need for an operating system. Its instruction set includes commands to create and destroy processes. A micro-coded scheduler shares processor time between concurrent processes. Different processes on the same transputer use memory to synchronise communications, whereas processes executing on different units communicate via the transputer's links.

## Sharing the Load

Enabling processors to work together is a fairly simple task. The same is not true for software components. Most transputer programming languages put the onus firmly on the programmer to code parallelism into his programs explicitly. In the case of C, which is primarily a sequential language, programs have to be broken down into a number of modules/tasks, each of which can be run in parallel. These tasks then communicate via channels.

The tasks and interconnecting channels that comprise a complete application must be configured for a processor network. Usually, the ideal network for a given program is one processor for each task, allowing maximum parallelism. In practice, a program must be able to run on a network of arbitrary size and topology. When there are fewer processors than tasks, some tasks must reside on the same processor and run concurrently. When there are more processors than tasks, it may be necessary to re-route messages.

The configuration of transputer programs generally takes place at either compile-time or load-time. The occam language allows

compile-time configuration: tasks and channels can be assigned to particular processors and links. While this allows a program to exert maximum control of the network, the program must be re-coded and re-compiled for each new network. With load-time configuration, the technique adopted by the compilers in this article, tasks are created and compiled separately, and a configuration map is used to define where the tasks and channels are to reside. Programs can be developed independently of any network, and configured for different networks by altering the configuration map.

## Root

To test the programming systems in this article, I wrote parallel versions of the a square root program, henceforth 'Root', which uses an iterative technique to calculate the square roots of a fixed sequence of numbers. The sequential version of the program is shown in Figure 1. The parallel versions use the network of transputers to reduce program execution time, by sharing the calculations out among the processors. Benchmark timings were taken for each system using a set of three weightings to give some indication of the communication overheads. The transputer benchmarks were run on MicroWay's Quadputer2 board, which consists of four T800s, running at 20 MHz. To provide some form of base measurement, the tests were also run using Microsoft C V5.0 on a 16 MHz 80386 PC, with no floating point processor. The results are shown in Figure 2.

## Parallel C

3L, the supplier of Parallel C, is a company specialising in parallel versions of mainstream sequential programming languages. The company's philosophy is to provide an easy migration route for those wishing to develop applications on the transputer. Their compilers are designed to be used within the normal PC environment, looking

```
#include "stdio.h"
#include "time.h"

#define PACKETS 100
#define ITERATIONS 1000

main()
{
    double    seed, x;
    long      u, v;

    seed = 1000.00; /* starting seed */
    for (u = 0; u < PACKETS; u++)
    {
        x = seed / 2.0; /* initial guess */
        for (v = 0; v < ITERATIONS; v++)
            x = x - ((x * x - seed) / (2.0 * x));
        seed += 1000.00; /* next seed */
    }
}
```

*Figure 1 - Sequential version of Root*



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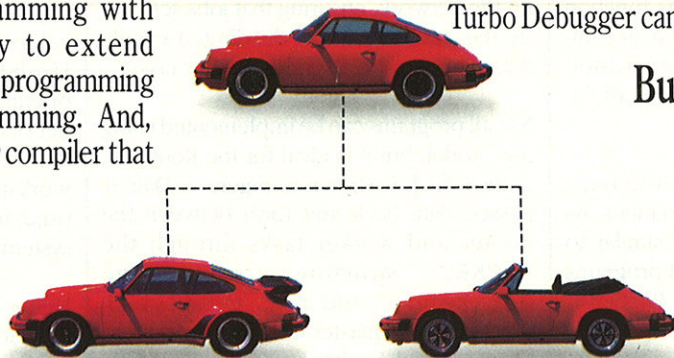
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## A fast object lesson

Object-oriented application programs more closely model the way you think. Objects contain both data and code. As in a spreadsheet cell, the value and the formula are together. Objects can *inherit* properties from other objects. For example, a Porsche Carrera inherits most attributes from base model 911, but it also sports a whale tail.



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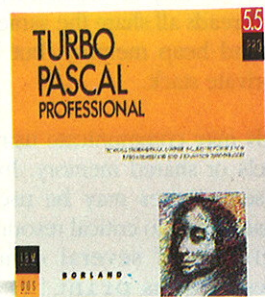
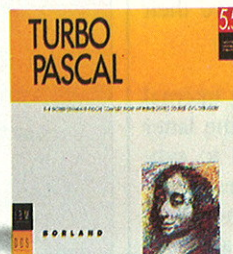
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Twyford, Berkshire RG10 9NN

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CIRCLE NO. 892



Figure 2 - Benchmark timings

Root Benchmark Timings/seconds				
PACKETS	ITERATIONS	3L (T800)	Helios (T800)	Microsoft (80386)
100	100000	18	170	6600
1000	10000	18	183	6600
10000	1000	19	238	6600

and feeling very much like their MS-DOS counterparts.

The latest addition to the 3L range is Tbug, an interactive source level debugger, which can be used with all the 3L compilers. It is similar to Microsoft's CodeView, but uses an overlapping (rather than tiled) windowing system, and boasts a very useful hyper-text help system. Unfortunately, it doesn't use the same commands as CodeView.

The Parallel C compiler supports the K&R specification of the language, but includes several ANSI extensions, such as function prototyping. The manual which accompanies the compiler, although not a masterpiece of clarity, contains just about all the information needed.

Parallel C achieves its concurrency through a comprehensive set of library routines. As the compiler is designed to be similar to MS-DOS C compilers, sequential programs may be recompiled within the Parallel C environment with little or no changes. Obviously, such programs run sequentially on a single processor.

To exploit parallelism, a program must be written as a number of tasks, which communicate over channels using special I/O functions. Within a task, concurrent process threads may be created dynamically. These threads all share the same static, external and heap memory, but have their own private stack.

Threads may communicate using internal channels or shared memory. In the latter case, semaphores may be used to synchronise access to critical resources. Parallel versions of several common I/O routines, such as `printf()`, are provided to allow multiple thread access.

There are two basic configurations available under Parallel C. The first allows tasks and channels to be mapped explicitly onto a particular network, using a configuration file to define the hardware and software topology.

The second method is the the processor farm model. In this model, programs automatically configure themselves to run on any network of transputers. As shown in Figure 3, the processor farm model requires that the program is divided up into two tasks: a master and a worker. A single copy of the master task is placed on the root processor, identical copies of the worker task are placed on all the others. The master task splits the work load into a number of smaller job units, and sends them out onto the network to be handled by the worker tasks. The load balancer controls all traffic on the network, ensuring that jobs sent out by the master task are distributed evenly throughout the network of worker tasks.

Not all programs can be implemented using this model, but it is ideal for the Root program, which is shown in Figure 4. Data is passed back and forth between the master and worker tasks through the `PACKET` structure, using the `net_send()` and `net_receive()` functions. The master task sets the data to be processed in the seed field, and its square root is returned in the `root` field. As the master task cannot make any as-

sumptions about the order in which tasks are completed, the packet number is also included within the packet, so returned data can be re-assembled into the original order. To ensure maximum throughput, the master task creates two concurrent processes, `send()` and `receive()`, to handle the creation and retrieval of these packets.

The benchmark timings in Figure 2 show that the 3L versions of Root are the fastest in the table, reflecting the low overhead imposed by the compiler and network manager. In addition, the timings remain consistent as the communications traffic increases. The benchmark programs were also run on a single transputer, and the quadputer benchmarks were consistently three times as fast as the single transputer counterparts.

## Helios

Helios is a UNIX-like multi-tasking operating system, developed by Perihelion Software. Its development is closely linked to that of the Atari Transputer Workstation (ATW), née the Abaq, which was developed by its sister company, Perihelion Hardware: the ATW uses Helios as its native operating system. However, due to a number of commercial and technical problems, the ATW has made little impact on the workstation market. Helios-PC, which was used in this review, is the development system for PC hosted transputer cards.

Helios is a distributed operating system; it has no central services supporting the whole system. Its design is based on the familiar client-server model, where application tasks request services from system

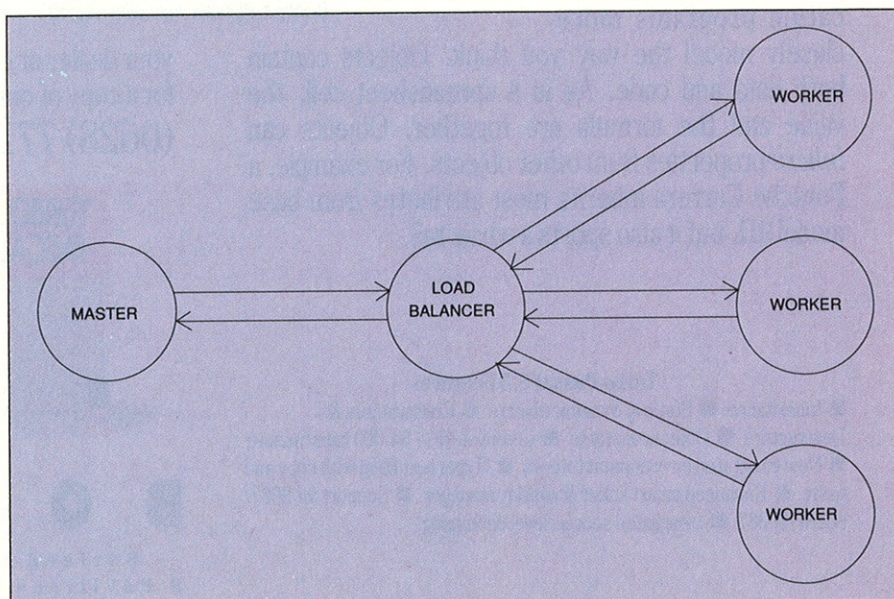


Figure 3 - The Farm model



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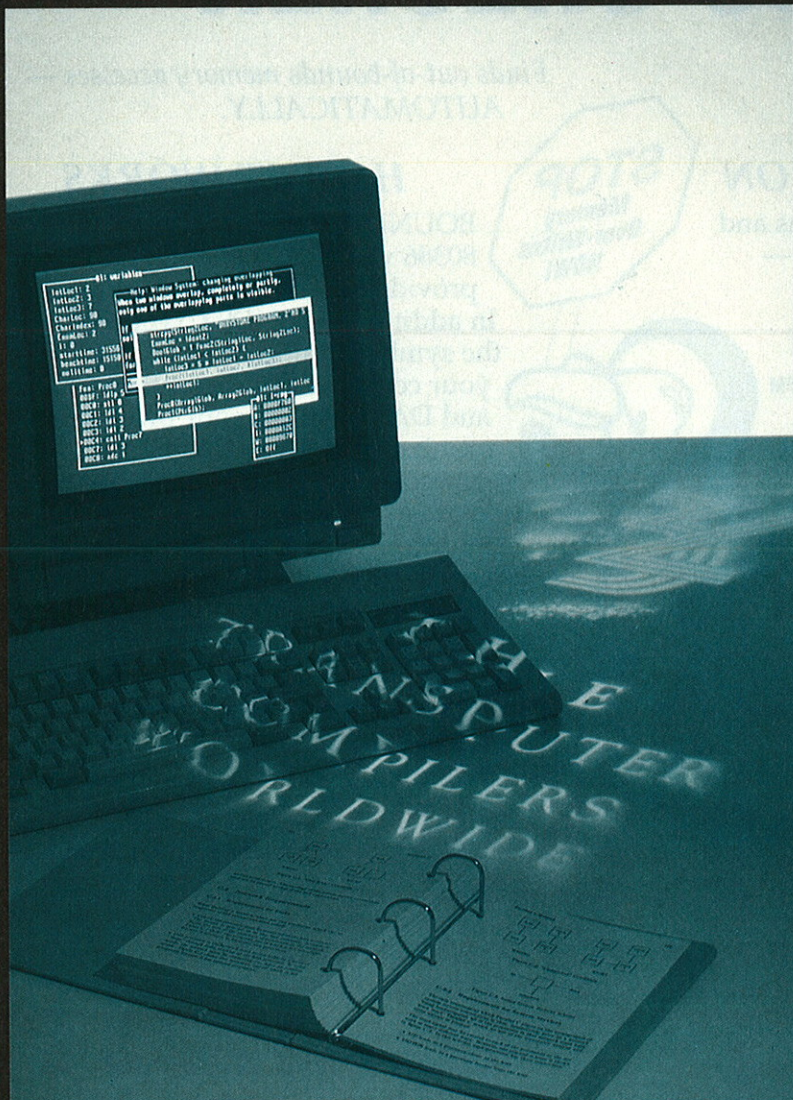
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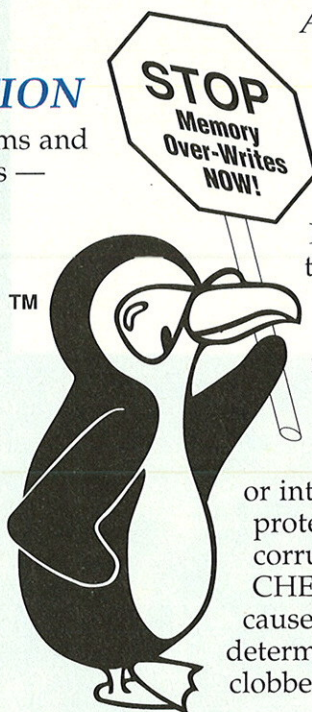
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provided server tasks. The Helios nucleus, along with any servers, such as file handlers, window managers, etc, must be present on each processor in the network. A comprehensive description of Helios appeared in .EXE Magazine, January 1988.

Installing Helios-PC is a fairly straightforward task, though configuring it for the Quadputer transputer board, which was used to perform all the tests described in this article, proved slightly more difficult, as no suitable driver was originally included in the package. Once the correct driver, plus an upgrade to V1.1a, had been obtained, no further problems were encountered. This upgrade highlights one of the main problems with Helios, namely it is a product that is still developing. Earlier versions of Helios had a reputation for being unstable, though many of these problems seemed to have been cured.

The Helios environment includes a shell very similar to the standard UNIX C shell. There is also a copy of the EMACS text editor, and a spartan selection of UNIX-like utilities. The Helios development system comes with a C compiler and assembler. The compiler supports many ANSI features, and the libraries are UNIX compatible, and designed to comply to the proposed POSIX

standard. A C source level debugger is also available.

There are three approaches to developing programs under Helios. The first is the traditional sequential model, in which a program runs as a single task under Helios. Thus, programs ported from environments such as UNIX or MS-DOS can be run under Helios with few changes. The second approach is to run an application program as a set of sequential tasks communicating through pipes. An example of this might be a compiler that can run as three tasks; pre-processor, code generator and linker, each task passing its output onto the next task. A single processor operating system would timeslice between these tasks, but Helios can allocate each one to a separate processor, so that they run in parallel. The final approach is to develop the program using parallel algorithms, explicitly dividing the program into a number of discrete tasks which distribute the program's workload.

Helios offers fairly course-grained parallelism: the smallest unit of execution that it deals with is a task. This technique can offer significant speed improvements for a small amount of programming effort. However, programs can still be developed using finer-grained parallelism, if required.

Helios uses its own language, Component Distribution Language (CDL) to define the tasks that make up an application program. A CDL definition consists of two parts; a description of how the tasks communicate with each other, and, optionally, details of the resource requirements for each task. The task force manager uses the CDL definition to map the tasks onto the network of processors. The advantage of CDL is that the application program can be defined in a way which is independent of the actual network. It is the task force manager which decides where to place the tasks, ensuring that the application program will work on a single processor or a network of processors.

CDL is designed to appear as an extension to the UNIX shell. For example:

```
ls | more
```

is actually a CDL script, which specifies that the programs `ls` and `more` are to run as two separate tasks, with the output of `ls` providing the input for `more`, as shown in Figure 5. Bidirectional pipes are also possible:

```
scroff <> filter
```

specifies two concurrent tasks, `scroff` and `filter`. `scroff` passes data onto `filter` for processing, and the output from `filter` is directed back to `scroff`, as illustrated in Figure 5. Several other similar constructs are also supported. Using these, it is possible to build quite sophisticated application programs. The optional description of resource requirements, mentioned above, is designed for tasks with specific requirements, such as a minimum amount of memory or access to a particular resource.

Rather than utilising special library calls, as with 3L's Parallel C, tasks under Helios communicate via the standard I/O library, using the `read()` and `write()` library functions. In the above CDL example, `filter` reads from standard input, and writes to standard output, and is thus unaware that it is running as a subordinate task for `scroff`. However, as `scroff` has to communicate with external tasks using its own standard input and output channels, it needs two additional channels for communications with `filter`; these correspond to the POSIX file descriptors 4 and 5.

## Root Under Helios

One of the most powerful CDL constructs is the farm construct, which corresponds very closely with 3L's farm model, shown in Figure 3. A master task communicates

```
#define PACKETS 1000
#define ITERATIONS 10000

typedef struct
{
    unsigned no; /* packet number */
    float seed; /* -> seed */
    float root; /* -> root */
} PACKET;

/* 3L : master task */

#include <stdio.h>
#include <dos.h>
#include <thread.h>
#include <sema.h>
#include <par.h>
#include <net.h>
#include <time.h>
#include "root.h"

SEMA sending;
int received = 0;
float roots[PACKETS]; /* store for results */

void send()
{
    PACKET pkt; /* master -> worker packet */
    int i;

    for (i = 0; i < PACKETS; i++)
    {
        double seed;
        unsigned u;

        sema_wait(&sending);

        seed = 1000.0; /* starting seed */
        for (u = 0; u < PACKETS; u++)
        { /* set packet #, set seed and send packet */
            pkt.no = u;
            pkt.seed = seed;
            net_send(sizeof(pkt), &pkt, 1);
            seed += 1000.00;
        }
    }
}

void receive()
{
    PACKET pkt; /* master <- worker packet */
    int i;

    for (i = 0; i < PACKETS; i++)
    {
        int ready;

        net_receive(&pkt, &ready);
        roots[pkt.no] = pkt.root;
        received++; /* update packet count */
    }
}

main()
{
    received = 0; /* no packets received */
    sema_init(&sending, 0); /* sending yet */

    thread_create(send, 5000, 0);
    thread_create(receive, 5000, 0);
    sema_signal(&sending);

    while (received < PACKETS)
        thread_deschedule();
}

/* 3L : worker task */

#include <net.h>
#include "root.h"

PACKET pkt; /* master -> worker packet */

main()
{
    while (1)
    {
        double x;
        int i, ready;

        net_receive(&pkt, &ready);

        x = pkt.seed / 2; /* initial guess */
        for (i = 0; i < ITERATIONS; i++)
            x = x - ((x * x - pkt.seed) / (2.0 * x)); /* iteration */

        pkt.root = x;
        net_send(sizeof(pkt), &pkt, 1);
    }
}
```

Figure 4 - 3L version of Root



Figure 5 - Communication of CDL tasks

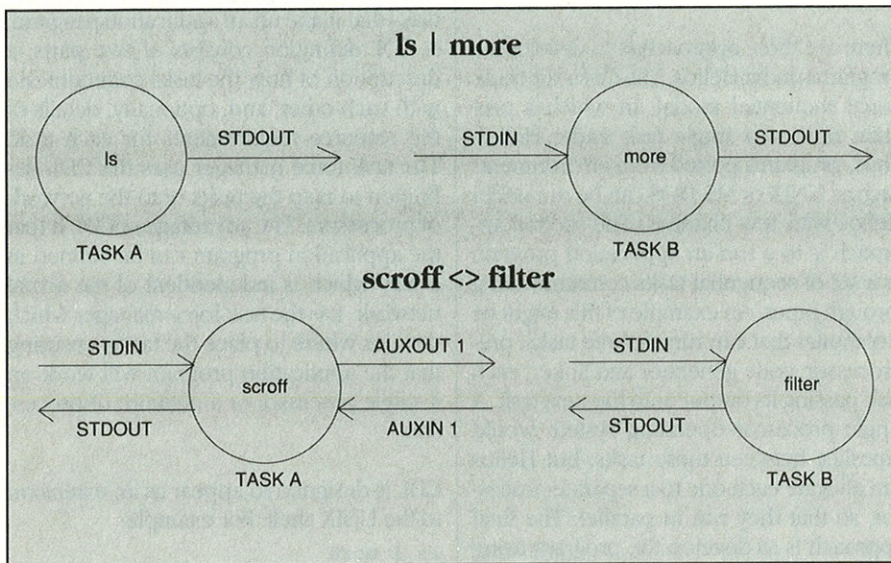


Figure 6 - Helios version of Root

```
#define PACKETS 1000
#define ITERATIONS 10000

typedef struct
{
    LB_HEADER header; /* load balancer header */
    unsigned no; /* packet number */
    float seed; /* -> seed */
    float root; /* <- root */
} PACKET;

/* HELIOS : master task */

#include <helios.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <sem.h>
#include <nonansi.h>
#include "newlib.h"
#include "root.h"

float roots[PACKETS];
Semaphore finished; /* semaphore:finished */

void send()
{
    PACKET pkt; /* master -> worker packet */
    double seed;
    int i;

    pkt.header.control = 0; /* normal packet */
    pkt.header.size = sizeof(pkt) - sizeof(LB_HEADER);

    /* send each packet */

    seed = 1000.0; /* initial seed */
    for (i = 0; i < PACKETS; i++)
    {
        pkt.no = i;
        pkt.seed = seed;
        write(5, (byte *) &pkt, sizeof(pkt));
        seed += 1000.00;
    }
}

void receive()
{
    PACKET pkt; /* master <- worker packet */
    int i;

    /* wait for each packet */

    for (i = 0; i < PACKETS; i++)
    {
        read(4, (byte *) &pkt, sizeof(pkt));
        roots[pkt.no] = pkt.root;
    }
}

Signal(&finished); /* signal finished */
}

int main()
{
    LB_HEADER terminate;
    time_t t;
    unsigned u;

    InitSemaphore(&finished, 0); semaphore */
    Fork(5000, &send, 0);
    Fork(5000, &receive, 0); /* ceive() thread */
    Wait(&finished);

    terminate.control = LB_MASTER
    + Fn Terminate; /* terminate flag */
    terminate.size = 0; /* no data portion */
    write(5, (byte *) &terminate,
    sizeof(terminate)); /* terminate */
}

/* HELIOS : worker task */

#include <helios.h>
#include <stdio.h>
#include <stdlib.h>
#include <unistd.h>
#include <sem.h>
#include <nonansi.h>
#include "newlib.h"
#include "root.h"

int main ()
{
    PACKET pkt1, pkt2;
    double x;
    unsigned u;

    while (TRUE)
    {
        read(0, (byte *) &pkt1, sizeof(pkt1));
        if ((pkt1.header.control & LB_FN)
        == Fn Terminate)
            exit(0); /* terminate */

        x = pkt1.seed / 2; /* initial guess */
        for (u = 0; u < ITERATIONS; u++)
            x = x - ((x * x - pkt1.seed)
            / (2.0 * x));

        pkt2.root = x; /* store result */
        pkt2.no = pkt1.no;
        pkt2.header.control = 0;
        pkt2.header.size = sizeof(pkt2) - sizeof(LB_HEADER); /* size */
        write(1, (byte *) &pkt2, sizeof(pkt2));
    }
}
```

with a number of identical worker tasks via a load balancer. The CDL script for the farm construct is

```
master [3] ||| worker
```

The '[3]' is a replicator, which specifies that three worker tasks are to be created. However, unlike the 3L farm model, any number of workers can be specified. As the load balancer is just another program task, the source code is provided, enabling more sophisticated and application-specific versions to be developed.

The Helios version of the Root program is shown in Figure 6. It is very similar to the Parallel C version. The LB\_HEADER construct must be part of the packet header so that packets can be handled correctly by the load balancer. The size field specifies the size of the packet, and the control field is used to broadcast to all the workers, in this case to issue the terminate command. Communication between tasks is through the standard read() and write() functions.

The benchmark timings for the Helios Root program run at about one tenth of the speed of the 3L versions (Figure 2), indicating the overheads imposed by the task force manager. To ensure comparability, the benchmarks were timed using three worker tasks.

## Conclusion

The 3L and Helios systems offer somewhat different approaches to program development under C. The 3L Parallel C compiler is designed to integrate into the normal MS-DOS environment, whereas Helios creates an entirely new UNIX-like development environment. They each have their own strengths and weakness - to some extent it's a trade-off between the amount of programming effort versus performance gain - but both let programmers get at the power of the transputer.

EXE

David Gristwood is in charge of new product development at Byline Software, which specialises in micro and mini computer software development. He can be contacted on 091-386 0286, or on CIX as 'scroff'.

### Product details:

The Parallel C and Tbug software packages cost £750 and £220 respectively, from 3L Limited (0506 415 959).

The Helios operating system (PC version) with C compiler costs £750, the Helios Source Debugger costs £485. Helios can be obtained from Distributed Software Ltd (0454 612 777).



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## Razor sharp

*Occam, the language that only gets a capital letter when it's at the beginning of a sentence, has an exotic reputation. Unfair! cries John Wexler.*

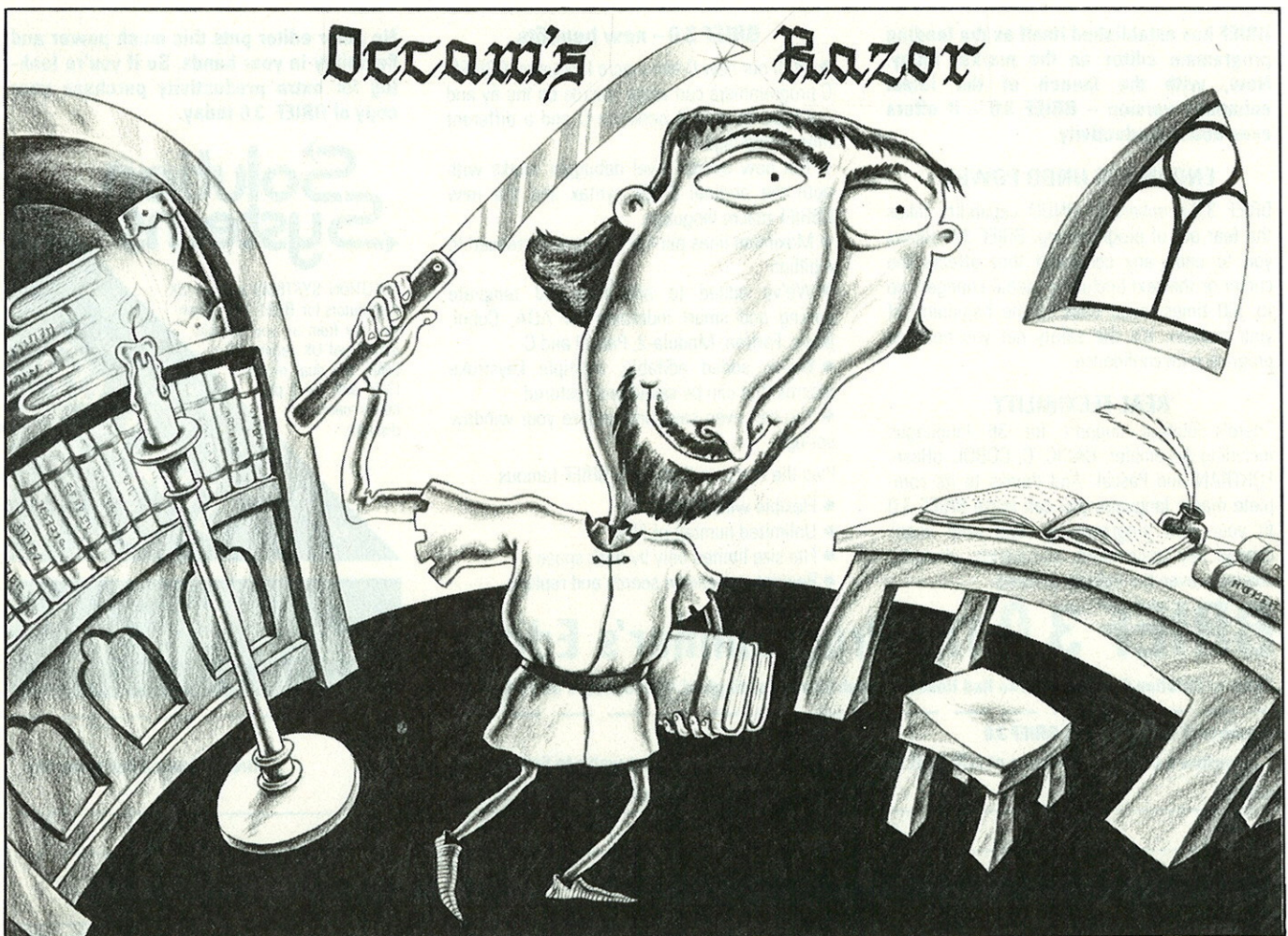
Let's plunge in at the deep end. Take a look at my solution to the Triangle Problem, shown in Figure 1. There you are: a fragment of an occam program. There are plenty of recognisable features - the words IF, AND and FOR; strings enclosed in double quotes; procedure calls, with parameters enclosed in parentheses; arrays subscripted using [ and ]; and declarations, each followed by a colon :, prefixed to the body of the text. In fact, it probably does not look as strange as you expected of 'that odd language that they use with transputers'. Clearly it is a tidily laid out program, in a familiar imperative language, and not at all weird like Prolog (declarative logic)

or Eiffel (object-oriented) or SML (functional) or LISP (list processing). 'No surprises, no complications' are the guiding principles of occam - and this is how it came by its name. The fourteenth-century English philosopher, William of Occam, coined the motto which is known as Occam's Razor: *non sunt multiplicanda entia praeter necessitatem* ('never multiply entities unnecessarily' ie 'keep it simple').

### Origins

These principles were not selected for fun, academic interest, or even love of Latin. They were essential for the commercial suc-

cess of a very major project: the development and marketing of the transputer. To attract attention, the product had to be revolutionary, it had to be targeted at several different markets, and it had to work better than its competitors. The 'revolutionary' aspect would lie in its unprecedented support for concurrency and multiprocessor working. Diversity of marketing sectors meant that it had to suit applications from single processor embedded systems to 1000 processor supercomputers. As for quality, it had to be very good indeed, and it had to be right first time. All of that meant that it could not be left solely in the hands of hardware engineers. Alongside the inputs



LYNNE CHAPMAN



from manufacturing technology, market analysis, logic design and so on, the design process had to accept a major contribution from the software side: system designers, compiler writers and, above all, theoreticians.

The chosen approach was to decide first which functions were required, and then to devise a machine-independent language which could express those very precisely. Only after that would the processor be designed, to implement that language as efficiently as possible. In this way, it was hoped to embody 'concept' in silicon with guaranteed correctness. The language, of course, became occam.

Now, up to this point, the idea of end users actually writing real applications in occam has not been mentioned; but a language which is simple, precise and susceptible to analysis is rather attractive for serious programming, especially if the user is also having to come to grips with the novel and tricky ideas of concurrency.

Inmos marketed the transputer and occam as a package. With hindsight, it is easy to see that this put some people off transpu-

ters, and made it easy for others to ignore occam. Fortunately, however, both have survived, and things look different now. Ironically, the turn-around has been much helped by the creation of transputer compilers for other languages, such as C, FORTRAN and Pascal. Occam depends on the transputer; the transputer needs to support conventional languages to succeed; hence occam's survival is partially attributable to the likes of C.

## The language

Occam is procedural imperative language with variables to which you can assign values (using the := symbol), sequences of instructions to be obeyed one after another, procedures and functions, and so on. It handles data of integer, Boolean, byte (character) and real types. You can have literals, named constants, variables and arrays (a string is handled as an array of bytes). It provides extra features for concurrent and real-time programming: primarily for specifying that several processes can be performed concurrently rather than in sequence, and for passing messages between them. There are timers for controlling delays. All in all, there are very few basic ideas,

and they are all very simple. Thus the official definition of occam is exceptionally compact, and even lucid. However, the ideas can all be combined, limited only by the programmer's ingenuity, to make up a comprehensive set of facilities for general as well as concurrent programming.

To many programmers in C and Pascal, the oddest thing about occam is that you cannot write it in free format. The indentation of each line of text is very important, and affects the meaning of the program. These indentation rules actually ensure that a program's layout is significant to the human reader as well as to a compiler. In effect, the programmer is forced to follow what, in Pascal, would be 'good practice'. Furthermore, there is a 'folding editor' for occam, which understands and supports these 'indentation rules', so it is not difficult to follow them. Incidentally, this is one of many cases where what is 'good practice' in other languages is made obligatory in occam.

At the heart of the occam is the concept of a 'process'. An example of a very simple process is the assignment of a new value to a variable is. Just as other languages have simple 'statements' which can be grouped

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Figure 1 - The Triangle Problem

```
[3]INT side:
a IS side[0]:
b IS side[1]:
c IS side[2]:
VAL OTHERWISE IS TRUE:
SEQ
  Readn (keyboard, a)
  Readn (keyboard, b)
  Readn (keyboard, c)
  SEQ i=0 FOR 3
    Writef2 (screen, "%i5*n", [side[i]])
  IF
    IF i=0 FOR 3
      side[i] > (side[(i+1) REM 3]+side[(i+2) REM 3])
      Writes (screen, "This is not a triangle.*n")
      (b=c) AND (c=a)
      Writes (screen,
        "This is an equilateral triangle.*n")
    IF i=0 FOR 3
      side[i]=side[(i+1) REM 3]
      Writes (screen,
        "This is an isosceles triangle.*n")
  OTHERWISE
    Writes (screen, "This is a scalene triangle.*n")
```

together to make 'compound statements' - perhaps between BEGIN and END - so occam can group several processes into one larger process (and so on, to any desired depth). As in Pascal, you can ask for the processes to be performed one after

another in a particular order. You write the word SEQ (for ‘sequence’) instead of BEGIN, followed by the processes in order. C programmers, who sneer at Pascal for its surfeit of BEGINs and ENDS, will be impressed by the fact that the indentation

of source text shows which processes are controlled by the SEQ, so there is no need for an END.

## Concurrency

There are, however, other ways to group processes. You can ask for several of them to be performed in parallel, simply by writing PAR instead of SEQ. That means that they can be done in any order, or perhaps by doing a bit of one and a bit of another until they have all been completed. If you have multiple processors, of course, they can be genuinely concurrent. The question then arises of how information can be shared between concurrent processes. In occam, they cannot share variables, but they can pass data from one to another through 'channels'. In fact the only primitive processes, apart from assignment, are the message-passing 'input' and 'output'.

CHAN OF INT forward:  
PAR

```

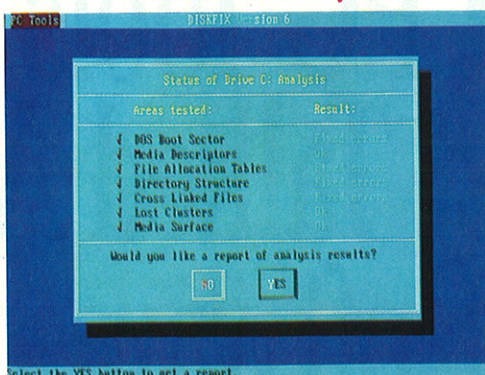
INT x:
SEQ
    x := 12
    forward ! x
INT y, z:
SEQ
    forward ? z
    y := z + 1

```

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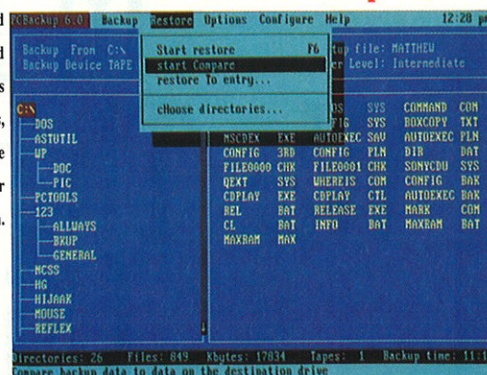


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Here we have two processes, to be performed concurrently (they are written after the PAR). Each of the two consists of a SEQUENCE of smaller processes. The first contains an assignment, followed by an output, denoted by the ! symbol. The other consists of an input (marked by ?) followed by an assignment. On the first line, forward is declared as a channel which can carry messages consisting of single integers. forward is in scope through the whole of the 'parallel' construct. Declarations are prefixed to a process, and apply to the whole of that process, but no further. Similarly, the single integer variable x is in scope for the three lines beneath its declaration.

What will happen when we run this? The interesting part is the input/output pair. When one process does forward ! x and the other does forward ? z, the value of x is transmitted from one process to the other and stored in z. The effect is like an assignment  $z := x$ . However, we could not write  $z := x$ , because x belongs to one process and z to the other, and processes may not share variables. We could, perhaps, describe the effect of the input and the output as a 'distributed assignment'.

The first SEQ forces  $x := 12$  to take place before the output forward ! x. Similarly, forward ? z will happen before  $y := z + 1$ . But will  $x := 12$  start before or after forward ? z? It's impossible to say! This is one of the difficulties with concurrency - you never know exactly in what order things will happen. Then how can I claim that occam is precise and unambiguous? It turns out that it simply does not matter which one starts first. Regardless of when forward ? z starts, it cannot finish until the other process has done forward ! x.

There is a momentary synchronisation between the two processes. Whichever process comes first to attempt an input or an output, that process will be suspended until the other participant performs the complementary input or output. (Putting it another way, the channel does not buffer messages.)

## Multi-channel

In systems of many concurrent processes, it often happens that one process has to communicate with a number of others. This is easily done in occam, by using a different channel for each line of communication. In

real systems, however, there is a complication: a process which has to be able to handle input from several others may not 'know' which one is going to offer input next. It must, therefore, attempt an input for more than one channel. It cannot use the ? operator in a SEQ compound process, so occam provides for this with a construction marked by the word ALT (for 'alternative').

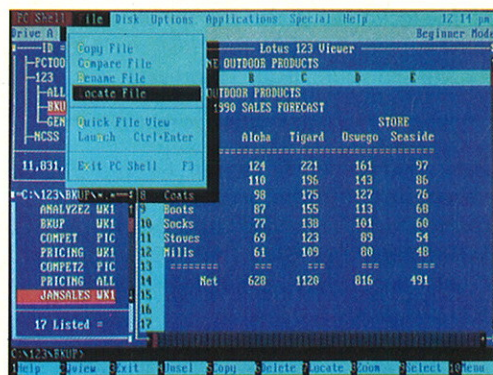
```
ALT
  fromTom ? a
    x := a + 1
  fromDick ? a
    x := a - 1
  fromHarry ? b
    SEQ
      x := x + b
      a := 1
```

After ALT, you list all of the possible inputs, following each one with the process that is to be performed if that input is received. The whole ALT process will accept just one of the inputs, and perform the one corresponding process. Which of the inputs will be chosen? Whichever one becomes available first. If more than one is ready when the ALT is started, then any of them will be chosen; the others will remain available, and can be accepted some time in the future.

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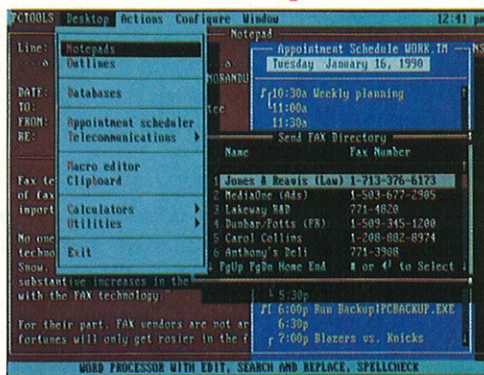
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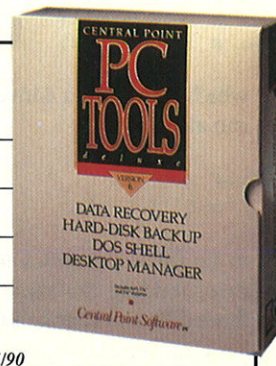
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.EXE 5/90





The strange thing about ALT is that it introduces a non-determinacy into the language. If a program contains even one ALT, it is impossible to predict how it will behave! And do I still claim that occam is precise and unambiguous? I do - but not, perhaps, in the sense which sequential programmers would like. A degree of non-determinacy is unavoidable in concurrent systems. Occam confines it to one very clear and simple part of the language, and gives you the best chance of understanding it and coping with it - it is as good as you can get in a difficult situation.

Besides SEQ and PAR and ALT, occam offers two more groupings of processes - WHILE and IF. On the whole, these behave pretty much what you would expect, although IF does differ from the norm. In most languages, the basic IF construction says 'IF condition THEN do this ELSE do that'. You build up more elaborate control structures by compounding 'IFs within IFs'. In occam, IF can be followed by a list of as many conditions as you please, with a process corresponding to each condition. The list of conditions is scanned, until one is found which is TRUE; the process which corresponds to that condition is performed. This means that there is less need for nested IFs. However, you do have to write 'IF condition THEN do this ELSE do nothing' when you just mean 'IF condition THEN do this'. It looks like this:

```
IF
  a=0
    x := x + 1
  TRUE
  SKIP
```

SEQ, PAR, ALT, and IF can all be followed by any number of processes. This leads to an interesting generalisation of the loop, which is called a 'replication' in occam:

```
SEQ i=0 FOR 3
  x := x + p[i]
```

which is equivalent to

```
SEQ
  x := x + p[0]
  x := x + p[1]
  x := x + p[2]
```

which is just like a conventional loop. You can also write

```
PAR i=0 FOR 3
  out[i] ! id
```

to do three processes in parallel - in this case, sending the same data out through three different channels (out is an array of

channels). Naturally, you can apply replication to IF in exactly the same way, like this:

```
IF i=0 FOR 3
  name[i]<>pattern[i]
  mismatch := i

means

IF
  name[0]<>pattern[0]
  mismatch := 0
  name[1]<>pattern[1]
  mismatch := 1
  name[2]<>pattern[2]
  mismatch := 2
```

which scans two arrays, and assigns the index of the first non-matching elements to mismatch. In other languages, this would be a construction where you would be tempted to use GOTO to get out of the loop when the first mismatch had been found; or

## The official definition of occam is exceptionally compact, and even lucid

you would find some other more of less subtle mechanism to express what is really quite a simple requirement. None of that is necessary in occam; in fact, given that there is also WHILE construction (and a CASE), occam needs no GOTO at all. It simply is not in the language!

The absence of GOTO is one feature which makes it possible to analyse occam programs with logic. Another is a total ban on side-effects of all kinds. All storage allocation is on the stack; there is no heap, and no equivalent of C's malloc(). Pointer variables are not used, but there is something called an 'abbreviation', which serves some of the same purposes without any risk of such notorious pointer-related bugs as 'dangling references' and 'conflicting usage'. Occam is extremely rigorous about data types, and will never do a type conversion unless the user explicitly asks for it. There are comprehensive rules forbidding potentially risky sharing of data channels between concurrent processes. All of this means the occam programs can be exten-

sively checked during compilation, saving a great deal of debugging later.

## Restrictions

Occam 2 has two principle restrictions, by comparison with (say) Pascal: it has no recursion, and all storage allocation is static (that is, all addresses can be calculated at compile time, or at least before the program is loaded). There are two reasons for this. First, it is very hard to do recursion and dynamic storage allocation on behalf of a number of processes which are running concurrently and asynchronously, and current transputers give no hardware support to make that any easier. Second, if one allowed them, 'running out of store' could happen at any time, unpredictably, and that would make it impossible to guarantee the behaviour of real-time safety-critical systems.

Occam also lacks 'unions', 'structures', 'records' or the like and in fact it has no way for the programmer to define new 'types' of data.

Now we can look back at the 'triangle program'. The main program is controlled by SEQ. Within that, there are three procedure calls on Readn to accept the input, followed by a replicated SEQ - a loop - for printing out the three given numbers, and finally an IF to apply the tests. This IF has four separate tests for the four conditions: 'not a triangle', 'equilateral', 'isosceles' and 'scalene'. Two of those conditions - 'not a triangle' and 'isosceles' - are themselves implemented by replicated IFs. There are abbreviations a, b and c for the elements of the side array which illustrate the use of this technique. I also use the abbreviation (sic) OTHERWISE for TRUE to clarify the final condition in an IF process.

[EXE]

*John Wexler works at the Edinburgh University Computing Service, where he is connected with the Edinburgh Concurrent Supercomputing Project, which has a Meiko Computing Surface comprising of around 500 transputers.*

*If you want to find out more about occam, he recommends his own book Concurrent Programming in occam 2 (pub Ellis Horwood, ISBN 0-7458-0394-6) and also the occam 2 Reference Manual (pub Prentice Hall, ISBN 0-13-629312-3). If you prefer a really heavy read, he suggests getting a book on Ada instead.*

*If you have a favourite, non-mainstream language, and you would like to write about it for 'The Third Side' series, please write to The Editor, at the address given on page 2, for a copy of the guidelines.*



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CIRCLE NO. 897



# 01 for dBASE

*On the 6th of May, British Telecom is to abandon the London '01' dialling code, invalidating thousands of telephone databases. Dave Atkins has a dBASE program to put things to rights.*

This month, British Telecom replaces London's 01 dialling code with two new codes: 071 for inner London and 081 for outer London (ie BT has added one extra decimal digit to the London phone number, but has only doubled the total of available numbers - digest and discuss). You will probably have seen some of the many adverts which have recently appeared for software utilities - usually ambitiously priced - which automate the major job of changing London telephone numbers. There is no need to spend money on such solutions. If you sit

down and think about what needs to be done, the program to perform this process is straightforward. To save you this effort, this article presents my dBASE IV solution.

## Storage

Telephone numbers are normally stored in character fields in dBASE; this allows the inclusion of formatting spaces, brackets and dashes, not to mention extension numbers. Some people use separate fields for the dialling code, the telephone number

and any extension numbers; others combine them all in one field. My code deals with the case where the whole telephone number is combined in one field - adapting the program to other formats is a trivial exercise. Even within a single field, there are many ways in which telephone numbers can be entered - this is inevitably a punter-driven feature. For example, the .EXE Magazine number could be stored as (01) 994 6477, 01-994 6477, 01- 994 6477, (01)9946477 or 01-9946477, to name just a few. The important point is that the dialling

```

FUNCTION London_Codes
PARAMETERS Phone_No
* Function to convert Phone_No to new London
* dialling codes
* (Does not cope with international numbers)

PRIVATE First_Ch,Pointer,Number,Digits,STD_Code

* Remove leading spaces
Phone_No = LTRIM(Phone_No)

* Get first character to check format
First_Ch = LEFT(Phone_No,1)

* Get dialling code
DO CASE

* Format is (01) ....
CASE First_Ch = "("
    Pointer = AT(")",Phone_No)
    STD_Code = LTRIM(SUBSTR(Phone_No,2,
        Pointer-2))

* Format is 01 ... or 01- ...
CASE First_Ch = "0"
    Pointer = 1
    DO WHILE Pointer <= LEN(Phone_No)
        .AND. SUBSTR(Phone_No,Pointer,1) $
            "01234567890"
        Pointer = Pointer + 1
    ENDDO
    STD_Code = LEFT(Phone_No,Pointer-1)

ENDCASE

* If we have a London number...
IF STD_Code = "01"

* Extract phone number without dialling code
Number = LTRIM(RIGHT(Phone_No,LEN(Phone_No)-
    Pointer))

* Look up first three digits
Digits = VAL(LEFT(Number,3))
DO CASE
    CASE Digits = 200
        STD_Code = "(081)"
    CASE Digits >= 202 .AND. Digits <= 209
        STD_Code = "(081)"
    CASE Digits = 210
        STD_Code = "(071)"
    CASE Digits >= 212 .AND. Digits <= 215
        STD_Code = "(071)"
    CASE Digits >= 217 .AND. Digits <= 263
        STD_Code = "(071)"
    CASE Digits >= 265 .AND. Digits <= 281
        STD_Code = "(071)"
    CASE Digits >= 283 .AND. Digits <= 284
        STD_Code = "(071)"
    CASE Digits >= 286 .AND. Digits <= 289
        STD_Code = "(071)"
    CASE Digits >= 290 .AND. Digits <= 291
        STD_Code = "(081)"
    CASE Digits >= 293 .AND. Digits <= 295
        STD_Code = "(081)"
    CASE Digits >= 297 .AND. Digits <= 305
        STD_Code = "(081)"
    CASE Digits = 306
        STD_Code = "(071)"
    CASE Digits >= 307 .AND. Digits <= 314
        STD_Code = "(081)"
    CASE Digits = 315
        STD_Code = "(071)"
    CASE Digits >= 316 .AND. Digits <= 319
        STD_Code = "(081)"
    CASE Digits >= 320 .AND. Digits <= 329
        STD_Code = "(071)"
    CASE Digits = 330
        STD_Code = "(081)"
    CASE Digits = 331
        STD_Code = "(071)"
    CASE Digits = 332
        STD_Code = "(081)"
    CASE Digits >= 333 .AND. Digits <= 334
        STD_Code = "(071)"
    CASE Digits >= 335 .AND. Digits <= 337
        STD_Code = "(081)"
    CASE Digits = 338
        STD_Code = "(071)"
    CASE Digits >= 339 .AND. Digits <= 343
        STD_Code = "(081)"
    CASE Digits >= 345 .AND. Digits <= 349
        STD_Code = "(081)"
    CASE Digits >= 350 .AND. Digits <= 359
        STD_Code = "(071)"
    CASE Digits >= 360 .AND. Digits <= 361
        STD_Code = "(081)"
    CASE Digits >= 363 .AND. Digits <= 368
        STD_Code = "(081)"
    CASE Digits >= 370 .AND. Digits <= 389
        STD_Code = "(071)"
    CASE Digits >= 390 .AND. Digits <= 395
        STD_Code = "(081)"
    CASE Digits >= 397 .AND. Digits <= 399
        STD_Code = "(081)"
    CASE Digits >= 400 .AND. Digits <= 418
        STD_Code = "(071)"
    CASE Digits >= 419 .AND. Digits <= 424
        STD_Code = "(081)"
    CASE Digits = 425
        STD_Code = "(071)"
    CASE Digits >= 426 .AND. Digits <= 429
        STD_Code = "(081)"
    CASE Digits >= 430 .AND. Digits <= 439
        STD_Code = "(071)"
    CASE Digits >= 440 .AND. Digits <= 453
        STD_Code = "(081)"
    CASE Digits = 454
        STD_Code = "(071)"
    CASE Digits >= 455 .AND. Digits <= 456
        STD_Code = "(081)"
    CASE Digits = 457
        STD_Code = "(071)"
    CASE Digits >= 458 .AND. Digits <= 464
        STD_Code = "(081)"
    CASE Digits = 465
        STD_Code = "(071)"
    CASE Digits >= 466 .AND. Digits <= 472
        STD_Code = "(081)"
    CASE Digits >= 473 .AND. Digits <= 474
        STD_Code = "(071)"
    CASE Digits = 475
        STD_Code = "(081)"
    CASE Digits >= 476 .AND. Digits <= 477
        STD_Code = "(071)"
    CASE Digits >= 478 .AND. Digits <= 479
        STD_Code = "(081)"
    CASE Digits >= 480 .AND. Digits <= 499
        STD_Code = "(071)"
    CASE Digits >= 500 .AND. Digits <= 509
        STD_Code = "(081)"
    CASE Digits >= 510 .AND. Digits <= 513
        STD_Code = "(071)"
    CASE Digits = 514
        STD_Code = "(081)"
    CASE Digits >= 515 .AND. Digits <= 516
        STD_Code = "(071)"
    CASE Digits >= 517 .AND. Digits <= 521
        STD_Code = "(081)"
    CASE Digits = 522
        STD_Code = "(071)"
    CASE Digits >= 523 .AND. Digits <= 524
        STD_Code = "(081)"
    CASE Digits = 525
        STD_Code = "(071)"
    CASE Digits >= 526 .AND. Digits <= 527
        STD_Code = "(081)"
    CASE Digits = 528
        STD_Code = "(XXX)"
    CASE Digits >= 529 .AND. Digits <= 536
        STD_Code = "(081)"
    CASE Digits >= 537 .AND. Digits <= 538
        STD_Code = "(071)"
    CASE Digits >= 539 .AND. Digits <= 547
        STD_Code = "(081)"
    CASE Digits = 548
        STD_Code = "(071)"
    CASE Digits >= 549 .AND. Digits <= 579
        STD_Code = "(081)"
    CASE Digits >= 580 .AND. Digits <= 589
        STD_Code = "(071)"
    CASE Digits >= 590 .AND. Digits <= 595
        STD_Code = "(081)"
    CASE Digits >= 597 .AND. Digits <= 599
        STD_Code = "(081)"
    CASE Digits >= 600 .AND. Digits <= 613
        STD_Code = "(071)"
    CASE Digits = 615
        STD_Code = "(071)"
    CASE Digits >= 618 .AND. Digits <= 639
        STD_Code = "(071)"
    CASE Digits >= 640 .AND. Digits <= 648
        STD_Code = "(071)"

```

Figure 1 - The dBASE conversion function



Figure 1 - continued

```

STD_Code = "(081)"
CASE Digits >= 650 .AND. Digits <= 651
STD_Code = "(081)"
CASE Digits >= 653 .AND. Digits <= 661
STD_Code = "(081)"
CASE Digits >= 663 .AND. Digits <= 695
STD_Code = "(081)"
CASE Digits = 696
STD_Code = "(071)"
CASE Digits >= 697 .AND. Digits <= 699
STD_Code = "(081)"
CASE Digits >= 700 .AND. Digits <= 704
STD_Code = "(071)"
CASE Digits >= 706 .AND. Digits <= 716
STD_Code = "(071)"
CASE Digits >= 718 .AND. Digits <= 739
STD_Code = "(071)"
CASE Digits >= 740 .AND. Digits <= 752
STD_Code = "(081)"
CASE Digits = 753
STD_Code = "(071)"
CASE Digits >= 754 .AND. Digits <= 756
STD_Code = "(081)"
CASE Digits = 757
STD_Code = "(071)"
CASE Digits >= 758 .AND. Digits <= 761
STD_Code = "(081)"
CASE Digits >= 763 .AND. Digits <= 764
STD_Code = "(081)"
CASE Digits >= 766 .AND. Digits <= 771
STD_Code = "(081)"
CASE Digits = 772
STD_Code = "(071)"
CASE Digits = 773
STD_Code = "(081)"
CASE Digits >= 774 .AND. Digits <= 775
STD_Code = "(071)"
CASE Digits >= 776 .AND. Digits <= 778
STD_Code = "(081)"
CASE Digits = 779
STD_Code = "(071)"
CASE Digits >= 780 .AND. Digits <= 781
STD_Code = "(081)"
CASE Digits = 782
STD_Code = "(071)"
CASE Digits >= 783 .AND. Digits <= 789
STD_Code = "(081)"
CASE Digits >= 790 .AND. Digits <= 796
STD_Code = "(071)"
CASE Digits >= 798 .AND. Digits <= 799
STD_Code = "(071)"
CASE Digits >= 800 .AND. Digits <= 809
STD_Code = "(081)"

CASE Digits = 811
STD_Code = "(081)"
CASE Digits >= 818 .AND. Digits <= 824
STD_Code = "(071)"
CASE Digits = 826
STD_Code = "(071)"
CASE Digits >= 828 .AND. Digits <= 829
STD_Code = "(071)"
CASE Digits >= 831 .AND. Digits <= 839
STD_Code = "(071)"
CASE Digits >= 840 .AND. Digits <= 859
STD_Code = "(081)"
CASE Digits = 860
STD_Code = "(071)"
CASE Digits >= 861 .AND. Digits <= 864
STD_Code = "(081)"
CASE Digits = 865
STD_Code = "(071)"
CASE Digits = 866
STD_Code = "(081)"
CASE Digits = 867
STD_Code = "(071)"
CASE Digits >= 868 .AND. Digits <= 871
STD_Code = "(081)"
CASE Digits >= 872 .AND. Digits <= 873
STD_Code = "(071)"
CASE Digits >= 874 .AND. Digits <= 879
STD_Code = "(081)"
CASE Digits >= 881 .AND. Digits <= 886
STD_Code = "(081)"
CASE Digits >= 888 .AND. Digits <= 894
STD_Code = "(081)"
CASE Digits = 895
STD_Code = "(XXX)"
CASE Digits >= 897 .AND. Digits <= 900
STD_Code = "(081)"
CASE Digits = 901
STD_Code = "(071)"
CASE Digits >= 902 .AND. Digits <= 909
STD_Code = "(081)"
CASE Digits >= 911 .AND. Digits <= 912
STD_Code = "(071)"
CASE Digits >= 913 .AND. Digits <= 914
STD_Code = "(081)"
CASE Digits >= 915 .AND. Digits <= 918
STD_Code = "(071)"
CASE Digits >= 920 .AND. Digits <= 925
STD_Code = "(071)"
CASE Digits >= 927 .AND. Digits <= 939
STD_Code = "(071)"
CASE Digits >= 940 .AND. Digits <= 944

```

code is entered first, and is separated from the rest of the number by a combination of brackets, dashes and spaces. We need to split the entry into two sections, so that we can process the dialling code and the remainder of the telephone number separately.

I first tackled this problem by writing a small program which used a separate indexed database file to store the new dialling codes. This worked fine, but I decided that a user defined function (UDF) would provide a more general solution to the problem, and had the advantage that it could be used just like any other dBASE function. `London_Codes`, which is the UDF routine shown in Figure 1, turned out to be quicker than my indexed database solution.

`London_Codes` splits into three logical sections. The first task is to extract the dialling code from the telephone number field. The process assumes that it is stored in one of the formats shown above. To determine the way in which the number has been stored, we check the first non-space character. There are two main possibilities: an

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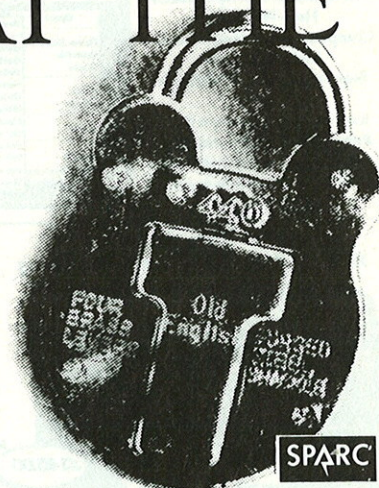
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CIRCLE NO. 898



Figure 1 - continued

```

STD Code = "(081)"
CASE Digits = 945
  STD Code = "(XXX)"
CASE Digits >= 946 .AND. Digits <= 954
  STD Code = "(081)"
CASE Digits >= 955 .AND. Digits <= 957
  STD Code = "(071)"
CASE Digits >= 958 .AND. Digits <= 961
  STD Code = "(081)"
CASE Digits = 962
  STD Code = "(071)"
CASE Digits >= 963 .AND. Digits <= 965
  STD Code = "(081)"
CASE Digits >= 967 .AND. Digits <= 969
  STD Code = "(081)"
CASE Digits >= 971 .AND. Digits <= 973
  STD Code = "(071)"
CASE Digits = 974
  STD Code = "(081)"
CASE Digits = 975
  STD Code = "(XXX)"
CASE Digits = 976
  STD Code = "(071)"
CASE Digits = 977
  STD Code = "(081)"
CASE Digits = 978
  STD Code = "(071)"
CASE Digits >= 979 .AND. Digits <= 981
  STD Code = "(081)"
CASE Digits = 982
  STD Code = "(XXX)"
CASE Digits >= 983 .AND. Digits <= 986
  STD Code = "(081)"
CASE Digits = 987
  STD Code = "(071)"
CASE Digits >= 988 .AND. Digits <= 989
  STD Code = "(081)"
CASE Digits >= 991 .AND. Digits <= 995
  STD Code = "(081)"
CASE Digits >= 997 .AND. Digits <= 998
  STD Code = "(081)"
OTHERWISE
  STD Code = "(???) "
ENDCASE

Phone_No = STD_Code + Number

ENDIF

RETURN (Phone_no)

```

opening bracket (we must search for the corresponding closing bracket to find the dialling code) or a digit (we must search for either a space or a dash as the delimiting character). Once the format of the dialling code has been sorted out, the SUBSTR command can extract the dialling code.

If we find a London number (dialling code is 01), then we need to test the first three digits of the remainder of the number. The main part of the UDF is a CASE statement, which looks up the new dialling code. You will see that it includes some 'gaps', where there are no valid London telephone numbers. If you have any such non-valid telephone numbers in your database, these will be picked up, and the 01 dialling code replaced by '???'. There are also a few values where the number cannot be automatically converted - these entries will be replaced by 'XXX'. It is certainly worth searching your database after translation, to see if either of these dialling codes is to be found. With a few manual alterations, your database will be up to date.

The final part of London\_Codes simply returns the whole telephone number (dial-

ling code plus the remainder of the telephone number), whether it has been changed or not. This result can be used by dBASE commands, such as REPLACE, to translate your databases:

```

REPLACE ALL Phone
  WITH London_Codes (Phone)

```

Remember that a translated London telephone number will contain extra characters (one extra digit, plus perhaps extra formatting), so do check, before you do anything, that the field is big enough to hold the revamped telephone number. Happy phoning!

EXE

Dave Atkins works at the Computing Centre at Cardiff College, University of Wales, as a Microcomputer Support Officer. His job includes advising on the use of microcomputers, and providing courses on many microcomputer based packages.

The code in this article is available for downloading from the EXE conference on CIX. Alternatively, you can send a formatted diskette and an SAE to the editorial address (given on page 2) and we will copy it. Mark your envelope '01 for dBASE'.

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# A new way through the barrier

*To get at the full address space of the 80386 processor, you must run it in protected mode, says Conventional Wisdom. But David Bailey knows about some undocumented features...*

Until people stop running the MS-DOS operating system on 386 and 486 machines - and there is little sign of this happening at the moment - there will remain a need to address more than 640 KB of RAM from 'real mode', the mode in which the 80386 chip is emulating its 8086 ancestors. Programs executing in real mode are limited to a 1 MB address space because addresses are calculated from the 16-bit segment and offset values by the formula:

Absolute address = (16 \* segment) + offset

Using this formula, it is possible to generate addresses up to 10FFEFh - slightly more than 1 MB - but the 8086 truncated the address to 20 bits, as we shall see. In practice, the memory between 640 KB and 1 MB is reserved for screen memory and the BIOS ROM. The remaining 640 KB of RAM must contain a copy of MS-DOS, plus any TSR programs you may be running. The practical limit on program size is about 400-500 KB, depending on the version of MS-DOS you are using and the size of any TSRs that you have loaded.

Two approaches are commonly used to bypass the 640 KB limit from MS-DOS. The first uses the standard interface to expanded memory (LIM) to switch blocks of memory into an unused portion of the address space above 640 KB. Alternatively, on 386 machines, this can be achieved by running MS-DOS in virtual mode, rather than real mode. In virtual mode the processor can make use of its virtual memory hardware to switch 4 KB pages of memory into the bottom megabyte of address space using a 386 memory manager.

Block switching is, of course, a very inelegant way of accessing memory - especially

from high-level languages - and a variety of so called 'DOS extenders' now offer a second, much more radical solution to the problem. At Salford University we use a home-made DOS extender, called DBOS.

***It is generally thought to be inherently impossible to address all the memory available***

We use it to run our FORTRAN 77 compiler, FTN77, under MS-DOS, with the processor in 32-bit protected mode (please see 'Anatomy of a DOS Extender', .EXE, July 1989 for further details). The DOS extender works by switching to protected mode to execute the program, and returning to real mode to access DOS or BIOS services. This technique lets you execute multi-megabyte programs from MS-DOS, and it has significantly reduced the pressure for a 'true' 32-bit operating system.

However, there are still circumstances when it would be convenient to address all the extra memory available on a modern PC from real mode. This is generally thought to be inherently impossible - you won't find it covered in any of the reference books. But recently I stumbled across an undocumented way of doing it. I rang Intel, to check the validity of my findings. Not only is the technique described below known

about, it is also supported, so it should work on such chips as the 386-SX, the 486 and, in due course, the 586.

## How it works

In order to explain this trick it is necessary to review the way in which the 80386 extends the 8086 architecture. Each of the 16-bit registers (AX, BX, CX, DX, SI, DI, BP, IP, and SP) is extended to 32-bits (EAX, EBX etc). These 32-bit registers are accessible from real mode using an 'operand size' prefix byte of 66h. MASM 5.0 'knows' about these registers, and will plant the prefix byte if you specify a 32-bit operation in 16-bit code. Using an 'address size' prefix (67h) it is also possible to make use of a whole new set of address modes which, at first sight, appears to let you address 4 GB of memory. A typical instruction, which would require both prefixes to run in real mode, would be:

```
MOV EAX, DS:[ECX]
```

This would use the contents of ECX as an offset into the DS segment to produce an absolute address which could span 4 GB. You can code this instruction with MASM 5.0 and execute it in real mode. However, if the contents of ECX exceed 64 KB, the 80386 traps this instruction with a 'General Protection Exception' (interrupt 0Dh). The problem is that in real mode the size of each segment is set to 64 KB. The check to prevent addressing outside a segment is really part of the protection mechanism in protected mode, and the limit of 64 KB is set up when the chip is reset.

This 64 KB limit is almost invisible to real mode programmers. It manifests itself when you try to use 32-bit addressing using the address-size prefix as above, or when



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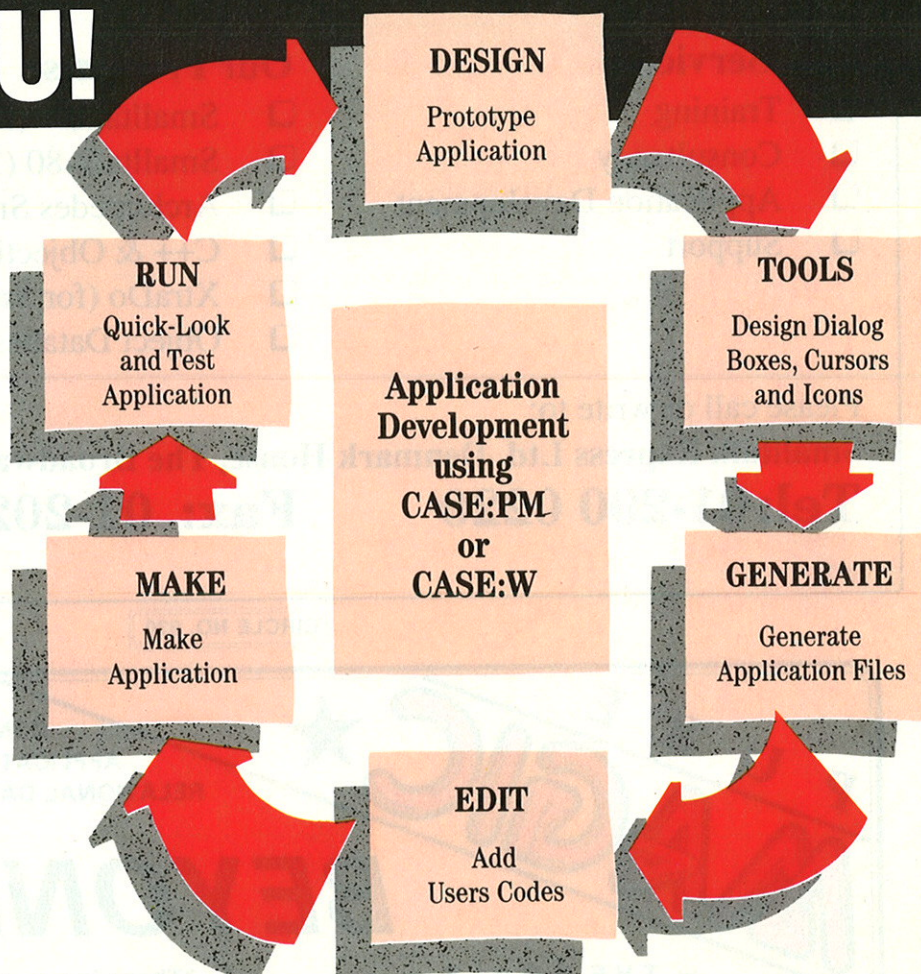
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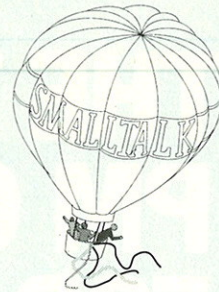
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Figure 1 - Program to access 32-bit address space in real mode

```

; Program to illustrate the direct addressing of extended
; memory from real mode
; Author: David Bailey, Salford University

; Use MASM 5.0 (or later) to assemble
;
; WARNING: THIS PROGRAM WILL DESTROY ANY DATA STORED IN
; EXTENDED MEMORY - DO NOT RUN WITH DISK CACHE
; SOFTWARE!
;

.model small
.386p
stack segment para stack 'stack' use16
db 64 dup('attack ')
stack ends
cseg segment para public 'code' use16
; Adjust the test_size parameter to suit your machine. You must have
; at least test_size*4 bytes of extended memory addressable from 100000h
test_size equ 10000h
start proc
    assume cs:cseg,ds:cseg,ss:stack,es:nothing
    push cs
    pop ds
    call address_setup ;Set things up for extended addressing
    mov ax,0 ;Offset 0 to FS -
    mov fs,ax ;addresses will be absolute

; Fill extended memory with numbers as a test
    mov eax,100000h ;Start at 1 MB
    mov ecx,test_size ;No of 4-byte words to store
p1:    mov fs:[eax*ecx*4],ecx ;Write to extended memory
    dec ecx
    jne p1 ;Loop round

; Confirm that the information has been retained
    mov ecx,test_size
p2:    cmp ecx,fs:[eax*ecx*4] ;Compare with data in extended memory
    jne err
    dec ecx
    jne p2 ;Loop round

done:  mov dx,offset okmessage
    jmp dl

err:   mov dx,offset errmsgage
    jmp dl

dl:    mov ah,9 ;DOS print message
    int 21h
    mov ax,4c00h ;terminate process
    int 21h

okmessage db 'Extended memory test succeeded',13,10,'$'
errmsgage db 'Extended memory test failed',13,10,'$'
start endp

; Procedure to set up A20 and the FS limit

opt equ 0 ; or 08fh (see text)
address_setup proc
; Set up the offset fields of CS and DS
    sub eax,eax ;Clear eax
    mov ax,ds
    shl eax,4 ;Abs address of CS,DS segments
    mov ebx,eax
    shr ebx,16 ;Top byte of address in bl
    mov cs_seg+2,ax
    mov byte ptr cs_seg+4,bl
    mov ds_seg+2,ax
    mov byte ptr ds_seg+4,bl

; Set up the offset field of GDT segment (used by BIOS)
    sub esi,esi ;Clear esi
    mov si,offset gdt
    add eax,esi ;Compute absolute offset of GDT
    mov gdt_seg+2,ax
    shr eax,16
    mov byte ptr gdt_seg+4,al

; Set up the offset field of SS
    sub eax,eax
    mov ax,ss
    shl eax,4 ;Abs address of SS segment
    mov ss_seg+2,ax
    shr eax,16
    mov byte ptr ss_seg+4,al
    word ptr the_stack,sp
    mov word ptr the_stack+2,ss
    in al,21h ;Save the IRQ interrupt mask
    mov int_mask,al ;(BIOS will destroy it)
    cll ;We don't want interrupts in protected mode!
    mov ah,89h ;Request switch to protected mode
    les si,agdt ;Address of global descriptor table in esi:si
    mov dx,0870h ;Do not change IRQ offsets
    int 15h ;Switch to protected mode and enable A20
    push es ;FS is to contain the big segment
    pop fs
    mov eax,cr0
    and eax,-2 ;Get control register 0
    and eax,-2 ;Remove the PE bit
    mov cr0,eax ;Back to real mode!

; Far jump to clear the prefetch buffer after mode switch
    db 0eah
    dd 0on

on:    lss sp,cs:the_stack ;Restore the stack
    push cs ;CS=DS in this routine
    pop ds
    lidt real_idtpt ;IDT must be set up again
    mov al,int_mask
    out 21h,al ;Restore IRQ interrupt mask
    sti ;Ready to take interrupts again
    ret

the_stack dd 0
real_idtpt dq 0ffffh
gdt dd 0,0,0,0 ;Dummy gdt entry
gdt_seg dw 0,0,0,0 ;Segment containing GDT itself
idt_seg dw 0ffffh,0,9300h,0 ;IDT=existing interrupt table
ds_seg dw 0ffffh,0,9300h,opt ;PM DS segment
es_seg dw 0ffffh,0,9300h,08fh ;PM ES segment moved to FS later
ss_seg dw 0ffffh,0,9300h,opt ;PM stack segment
cs_seg dw 0ffffh,0,9b00h,opt ;PM code segment
temp_seg dw 0,0,0,0 ;Used by BIOS
int_mask db 0
address_setup endp

cseg ends
end start

```

you try to reference a memory operand which spills over the top of a segment. For example:

```

MOV SI,0FFFFh
MOV AX,[SI]

```

The second instruction will generate interrupt 0Dh when executed on an 80386/486. The 64 KB limit also shows up if you execute instructions off the top of your code segment.

In protected mode, segments can have sizes ranging from 1 byte to 4 GB, depending on information contained in the Global Descriptor Table (GDT). Each time a segment register is loaded in protected mode, the segment register contents are used to index the GDT to extract the size, offset and certain other information about the segment. If the processor is returned to real mode, by resetting the PE bit in CR0, the current values are frozen. Subsequently, only the offset information is altered when a segment register is loaded, and the GDT is not referenced. By the way, it is this on-chip information which can be loaded directly by the `LOADALL` undocumented instruction ('The Code Page', .EXE, Septem-

ber 1989). However, this instruction is only guaranteed to work on 286 machines. It is also extremely clumsy to use, as it takes its data from a fixed area of memory normally used by MS-DOS.

DOS extenders like DBOS, which must repeatedly switch between real and protected modes, set up the segments with appropriate values before the switch back to real mode. These values then become frozen in, as described above. The *80386 Programmer's Reference Manual* advises that all segment registers should be set up with 64 KB limits for real mode, without saying what happens if you use other values. In fact, you can set up the FS and GS segments as you wish - since normal real mode makes no use of these registers, which do not exist on pre-80386 CPUs.

Now you can see how to address extended memory from real mode. You make one brief excursion into protected mode, and set the FS segment to a size of 4 GB. You then return to real mode, freezing in the new size information. Now, by using an FS-prefixed instruction, you can address *anywhere* in memory! You must take care

of one more detail. As mentioned above, the 80386 does not accurately emulate an 8086 in real mode in one respect: it does not truncate addresses at 1 MB. This means that, for example, the address FFFF:1000 refers to a location above 1 MB on a 386 machine and a location near the bottom of memory on an 8086 machine. Unfortunately, some early MS-DOS software (dismally) relies on this address wraparound, and 80386 PC manufacturers have incorporated special hardware to emulate this behaviour. This hardware disables address line 20 (A20), and is known as the gate A20 switch.

We can use a BIOS call to switch us into protected mode and enable gate A20 in one operation. I have found this function too slow when performing frequent switches, as in my DOS extender, but for the purposes of this article, the switch need only be done once, so efficiency is not an issue. The BIOS provides no way back from protected mode - indeed it provides no services at all in protected mode - so the return to real mode is achieved explicitly by resetting the PE bit in CR0. This leaves gate A20 enabled. The code required to perform all this is shown in Figure 1. The full explana-



tion for the values in the GDT can be found in the *80386 Programmer's Reference manual*. Since only very old software needs gate A20 disabled, you can probably leave it enabled after your program returns to DOS. Note that, back in real mode, FS is explicitly loaded with zero before use. This will force the offset of the FS segment to zero, and will mean that the address will be absolute. There is, of course, no need for a segment address component offset with a 32-bit segment size.

The ability to access extended memory directly has obvious value to the writers of TSR utilities. Normally, these programs must use memory sparingly since, once loaded, they permanently reduce the memory available below 640 KB. Once the FS segment and gate A20 have been set, they are unlikely to be reset. Only software which uses a LIM emulator or DOS extender might disturb these values. (My own program, DBOS, from version 2.01, explicitly leaves the machine set up ready to address extended memory). If in doubt, it is possible to check that all is well before attempting to access extended memory. Simply hook interrupt 0Dh (the general protection interrupt) and execute an instruction to address above 1 MB. If the program takes the interrupt, you know that you need to return to protected mode to set things up again. This test should be performed with external interrupts disabled, since external hardware, such as network cards, may use the interrupt. To test gate A20, simply compare a few bytes at location 0 with the corresponding values just above 1 MB. If they agree, gate A20 has presumably been disabled and you should re-execute the `address_setup` procedure of Figure 1.

## Code as well

Now that we can address unlimited memory from real mode, you may be wondering if it is possible to execute code from extended memory while in real mode. The answer is yes - but at a price. First, you must extend the size of the other segments. This can be done by changing the `opt` symbol in Figure 1 to 08fh. Next, it is necessary to move some code into extended memory, and transfer control to it with a 32-bit far return or jump. Control can be returned beneath 1 MB by executing a 16-bit far return. Figure 2 shows some example code that I have executed in this way, using the modified form of the procedure `address_setup` to set up the CPU. I ran the program under DOS's DEBUG, to pick up the embedded interrupt 3 call. DEBUG successfully reported CX containing 1234h - proving that the code in extended memory

Figure 2 - Sample program code, running in 32-bit address space

```

call    address_setup ;Set things up for extended addressing
mov     ax,0          ;Offset 0 to FS - addresses will be absolute
mov     fs,ax
cli     ;Interrupts off while in extended memory
; Move the instructions
mov     eax,200000h
mov     si,offset codex
mov     edx,[si]
mov     fs:[eax],edx
mov     edx,[si+4]
mov     fs:[eax+4],edx
; Leave a 16-bit far return on the stack to get back
call    far ptr t1
int     3             ;Display registers with DEBUG
mov     ax,4c00h      ;terminate process
int     21h

t1:
push    0             ;Push a CS of 0 extended to 32 bits
push    0             ;
mov     eax,200000h    ;Desired EIP
push    eax
db      66h           ;Operand size prefix
retf     ;Goto 0:200000
;
; The following two instructions are moved to 0:200000
; and executed there
codex:
mov     cx,1234h       ;Leave a signature in the registers
retf     ;Return to the int 3 instruction

```

had executed correctly.

Every JMP, CALL, RET or conditional jump executed in extended memory must be 32-bit (ie have the operand size prefix attached). Interrupts must be disabled while executing code in extended memory, since an interrupt would only save IP, not EIP. If you wish to transfer your stack into

**You can execute  
code from  
extended memory  
while running  
in real mode -  
but the price  
is very high**

extended memory, while executing instructions up there, you must make a further modification to the real mode environment. The last word of the stack segment entry in the GDT of Figure 1 must be changed from 'opt' to 0cfh. This will cause all stack references to operate using ESP rather than SP. Before switching to protected mode, it is advisable to clear the top half of ESP if you are experimenting with big stacks.

I am not sure whether it is worth manipulating code - as opposed to data - above 1 MB. It would clearly be necessary to descend from time to time to take external

interrupts or to issue interrupts to DOS or BIOS. However, my tests show that MS-DOS still seems to run with 4 GB segments and a big stack.

Please remember that none of the techniques described here will work in virtual mode. That means that you could not use them in conjunction with most memory managers, or with software such as DESQview/386.

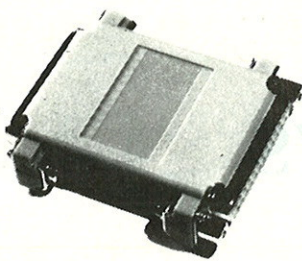
Finally, you may be wondering what use this technique has been to us. Programs compiled with our FORTRAN compiler (including the compiler itself) execute in 32-bit protected mode using DBOS and have no need for this trick in order to address extended memory. However, we have used the technique to implement a disk cache, based on any extended memory which DBOS is not using. Memory can be released from the disk cache when it is needed, and returned to the cache after program termination. This is an extremely efficient use of extended memory, since it is not necessary to partition extended memory into a disk cache and program area. The protection mechanisms ensure that an errant program cannot corrupt the contents of the disk cache. The cache operates by hooking the disk interrupt (13h) and addressing extended memory as described. The drawback is that the disk cache is not available when DBOS is run under DESQview/386, for the reasons explained above. We have no plans to execute serious real mode code in extended memory.

EXE

David Bailey is part of the group at Salford University which developed the FTN77/386 compiler. The compiler was reviewed in the May '89 issue of .EXE Magazine.



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# Opening Windows

*Resources form an important element of Microsoft Windows programming. The Whitewater Resource Toolkit aims to simplify creating and maintaining a program's resources.*

*Dave Jewell checks it out.*

*Resource: means of supplying a want; stock that can be drawn on.*

Under Windows, an application program's various menus, dialog boxes, icons, bitmaps, and so on are generally packaged as 'resources'. These are chunks of binary data, produced by a special resource compiler, then appended to the Windows .EXE file after the program itself has been compiled and linked. All the tools required to carry out this process are to be found in the Windows SDK package. Unfortunately, when it comes to getting the appearance of a dialog box or an icon just right, the process of refinement seems endless. Each little fix forces you to rebuild your program, run Windows, exit Windows, edit the dialog box definition, rebuild the program, and so on ad infinitum.

The Whitewater Group produces the Whitewater Resource Toolkit, an interactive resource editor designed to take the frustration out of Windows resource devel-

opment. This is the same company that developed the object-oriented Actor programming environment, and, in fact, the Resource Toolkit was itself written in the Actor language.

The biggest advantage of using the Toolkit is that you can create, edit and display resources without having to leave the Windows environment. This saves an immense amount of time, particularly for those of us who, like me, can't afford the latest 70 MHz 80586 box. Although Microsoft provides a dialog editor as part of the SDK, this program isn't capable of modifying resources in place within a .EXE file. The Toolkit, however, allows you to do just that. You can run your program, modify a dialog box, run the program again, and see the changes immediately. But don't get too ambitious - you must not try changing the resources of a program while it's actually running. If you do then, in the words of the manual, 'the system will throw up its hands and walk out on you.'

## Using the Toolkit

The Resource Toolkit comes on two 5.25 inch disks together with a slim manual. Installation consisted simply of inserting the first disk, typing 'INSTALL' and following screen instructions. You end up with two main files, WRT.EXE and WRT.IMG, in a directory of your choosing. The WRT.IMG file is no lightweight, weighing in at over 400 KB. There is also a special font file, called RESYM.FON, which contains the special characters used by the Resource Toolkit program.

I found it quite difficult to get to grips with the manual, mainly because of the laboured way in which it explains the function of every possible control of every possible dialog box. After all, the Toolkit is aimed at professional programmers, not computer novices. Having said that, I've no doubt that all the necessary information is there, if you can track it down.

To run the Toolkit program, you just double-click the WRT.EXE file in the normal way. After an initial welcome screen, you'll see the main dialog shown in Figure 1. The top half of the dialog box contains two 'picker' lists, each of which enables selection of a specified resource file and, subsequently, a resource within that file. Normally, you would choose one resource file, then proceed to edit its existing resources or add new ones. But you can use the two pickers to select two different files and exchange ('move') resources between them. For this reason, Whitewater has named this main dialog 'the Mover screen' (a slightly desperate piece of nomenclature, presumably devised after a certain amount of head-scratching).

The bottom half of the main dialog allows you to specify the resource types which are currently of interest. Any 'unclicked' re-

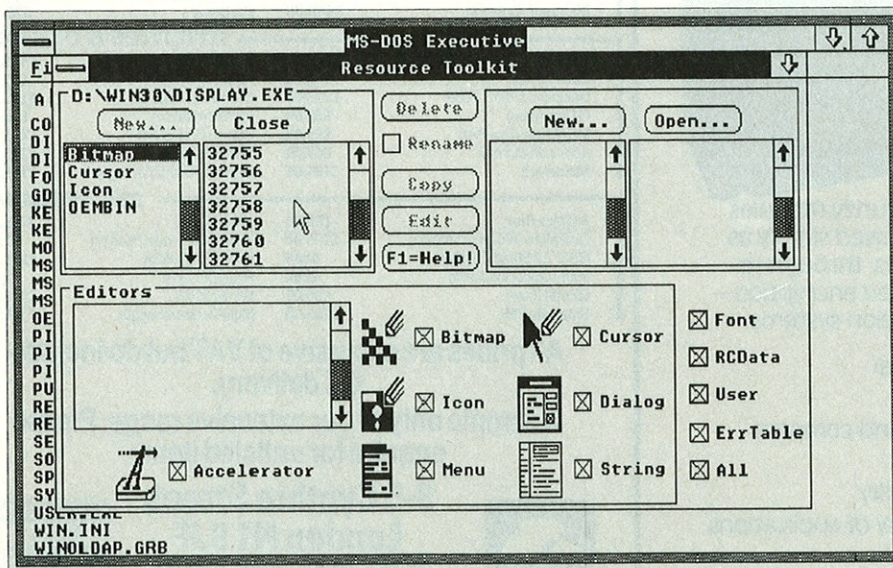


Figure 1 - Main screen of Resource Toolkit



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source types will be filtered out of the various picker lists which appear. The scrollable list box towards the bottom left allows you to bring different editor windows to the front, for those cases where you're editing more than one resource type at once.

The Toolkit supports the seven most common Windows resource types: bitmaps, icons, menus, cursors, dialog boxes, strings and accelerators. There is a built-in editor for each type, which understands the resource format and provides appropriate editing facilities. For example, Figure 2 shows the dialog editor in use.

If you have a resource which doesn't fit into one of these seven categories, the Toolkit will display it in the 'picker' list associated with each resource file, but you won't be able to modify it. This is likely to be a problem for Windows programmers who have made extensive use of the RCData facility provided by RC.EXE, the Microsoft Resource Editor. (If you want to define a new application-specific resource type, RC allows you to do this by giving the resource a type of RCData. It's a sort of generic data type, and can be used for any purpose.) I feel that the ability to edit unrecognised resource types is a significant, and unnecessary, omission from the Resource Toolkit. It would have been better to provide a default editor for unknown resources, which could let you patch your files, in hexadecimal, on a byte by byte basis. Even a clumsy tool is better than nothing.

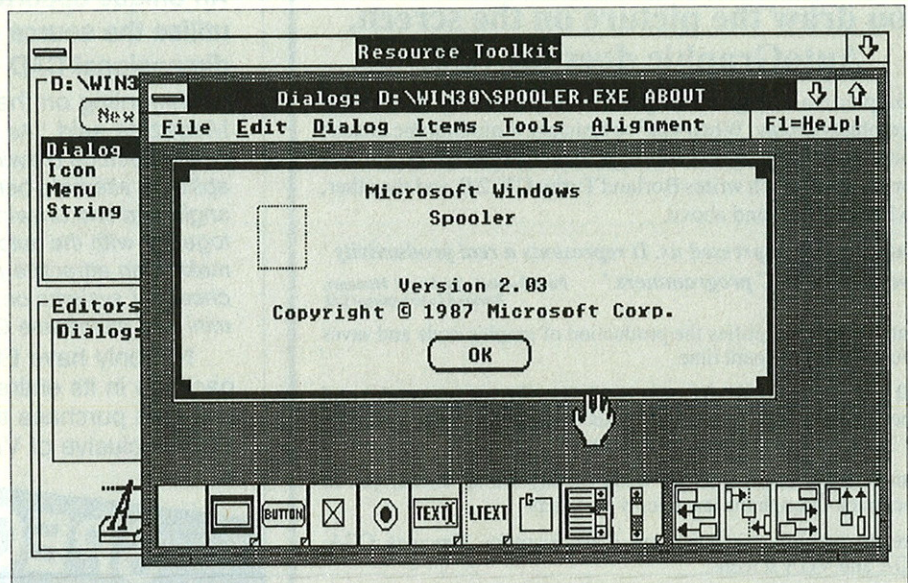
Direct support for header files is a nice feature of the Toolkit. This allows you to associate a header file, containing a list of #defines, with a resource type. Once this is done, you can refer to resources by name rather than by numeric ID.

The Toolkit supports resource files with the following extensions:

- .BMP (Bitmap resource data.)
- .CUR (Cursor resource data.)
- .ICO (Icon resource data.)
- .RES (Resource data compiled with the Resource Compiler, but not yet appended to the end of the Windows application file.)
- .EXE (Resources contained within the final, executable application.)

You can also use the Toolkit to generate .RC files (these are the input scripts which are used as 'source code' by the resource compiler).

Figure 2 - The dialog editor in use



Because the Toolkit allows you to edit compiled programs, you can look at the resources to be found inside existing Windows applications. The Microsoft Windows display driver contains a set of bitmaps that correspond to the various little graphical 'gizzmos' of the Windows interface: the minimise and maximise buttons, the arrows used for making scroll-bars, and so on. Microsoft puts all this stuff into each display driver so as to provide a set of gizzmos (sorry, I can't think of a better word) which look good for the particular screen resolution used by that driver. I thought it would be interesting to make my copy of Windows look a little more like the Motif interface. I renamed my copy of DISPLAY.DRV to DISPLAY.EXE (so that the Resource Toolkit could see it) and used the Whitewater Toolkit to edit the various resources inside the display driver. I renamed the driver back to what it was, re-installed Windows, and hey presto! instant Motif... Well, almost. Figure 3 shows one of the display driver gizzmos in the bitmap editor, ready to receive the Motif treatment.

## Editors

The editors provided in the Resource Toolkit are very full-featured. They're a bit like miniature painting/drawing applications in their own right. The bitmap editor, for example, provides tools to change the pen width, draw free and constrained lines, filled and unfilled rectangles, polygons, ellipses, and so forth. The dialog editor is especially comprehensive. There is a set of alignment functions, which allow you to do things like selecting a group of dialog controls and aligning them along one edge, or making them all the same size, or even spreading them out evenly along the horizontal or vertical axis. Funnily enough, it's

this one feature of the dialog editor which, more than anything else, would make me want to buy the Toolkit. I get really irritated if I see that one of my dialog buttons is a pixel higher than its neighbour, and used to waste a lot of time, peering at the screen, getting things lined up correctly.

## Performance

While the Resource Toolkit contains a number of features which are worth having, I was a little disappointed with the performance. On a 640 KB machine, without EMS memory, the system ran rather slowly, even though I was using a 2 MB RAM cache. The Resource Toolkit takes a lot of memory and, in fact, Whitewater recommends a minimum of 1 MB of expanded memory. While I haven't had much experience of using Actor, I suspect that the performance problem was partly due to the fact that the package was written using version 1.2 of that language. Using EXEHDR, a utility that comes with the Windows SDK, I discovered that the WRT.EXE program contains only one code and one data segment. Both of these segments are fixed and are the best part of 64 KB in size. This is just not acceptable practice in Windows programming. It's tantamount to declaring war on the Windows memory manager. Presumably version 2.0 of Actor, which is claimed to provide more usable memory, will go some way towards reducing this overhead.

## Conclusions

While using the Whitewater Resource Toolkit, I found myself continually comparing it with a program called ResEdit, which runs on the Apple Macintosh. For those unfamiliar with the Mac, ResEdit performs a very similar job to that addressed by the White-



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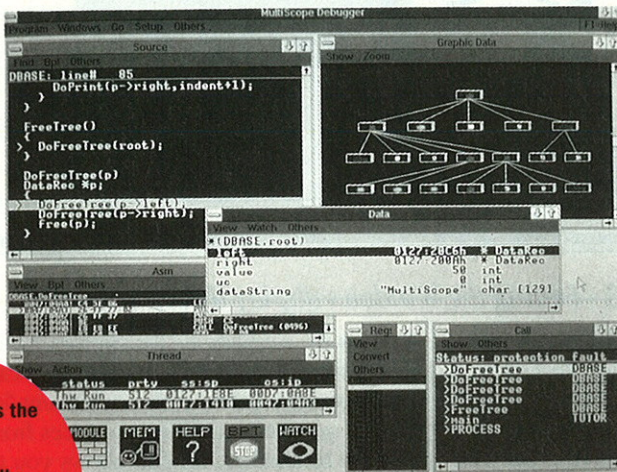
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- ▶ the next watchdog activation



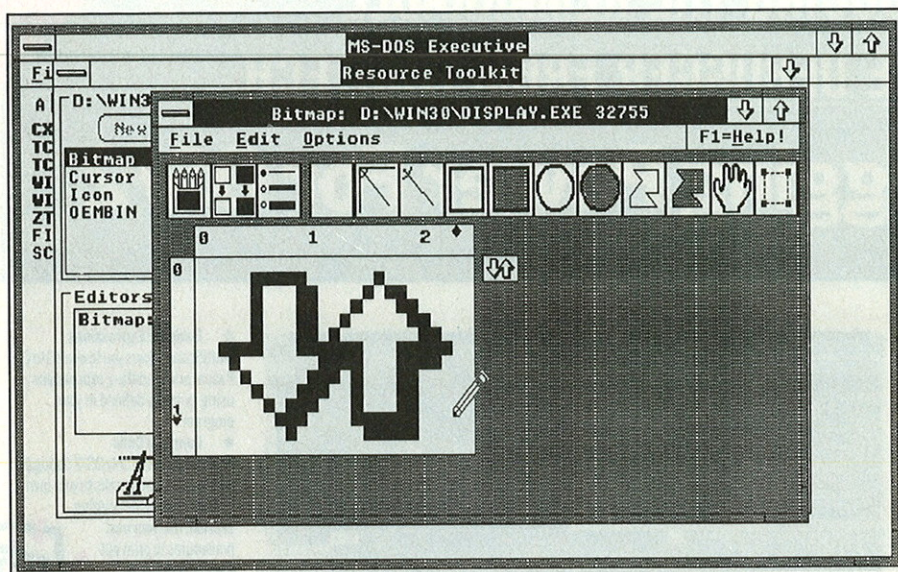


Figure 3 - Editing the Windows display driver

water product but, undeniably, it boasts a much more intuitive interface. ResEdit presents resources in a cleaner, more obviously hierarchical fashion: double-clicking on a filename displays a new window, showing a list of resource types within that file. Double-clicking on one of these resource types yields yet another window containing a list of all resources of that type. Finally, double clicking on an individual resource

invokes the resource editor appropriate to that resource type. With ResEdit you can instantly move between these different 'levels'. If you need to move resources from one file to another, ResEdit allows you to simply select the required resources, perform a Cut or Copy operation, and then Paste the resources into the destination file of your choice. This does away with the need for two separate 'picker' displays.

ResEdit also scores in the area of extensibility. It is possible, on the Macintosh, to write your own resource editor modules and add them to the ResEdit program file. This sort of thing could be accomplished under Windows by creating a .DLL library of custom resource editors.

However, despite the unexciting documentation and the shortcomings of the user interface, there's no doubt that this package is a vast improvement on the dialog editor provided by Microsoft. It should drastically reduce the amount of time required to develop resources for Windows applications and should find a place on the book shelf of every Windows programmer. My only real reservation about the usability of the program concerns the large amount of memory it consumes. Windows can easily slow to a crawl while you're using the Resource Toolkit. Any serious user will need to invest in some EMS memory.

EXE

Dave Jewell works for the Sign Express Group, Basingstoke, as a Senior Consultant. He can be contacted on CIX as 'djewell'. The Whitewater Resource Toolkit costs £145 and is available from Neow Ltd (0628 668334).



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# Borland's Paradox Engine

*The Paradox Engine is a library of routines, callable from C or Turbo Pascal, that lets you read and write Paradox files. Andy Redfern tried it out.*

When Borland first introduced Paradox, the critics chimed in unison 'No chance'. No one really believed that Borland could break the Ashton-Tate stranglehold on the database sector, without making it at least dBASE compatible. But both incompatible and successful it has been.

Paradox is a relational database management system (RDBMS) that allows tables (Paradox's name for database files) to be connected together explicitly through links. To provide full control, and to shield the user from the complexities of Paradox, PAL (Paradox Application Language) is included. This provides the programmer with a simple high-level language interface that takes full advantage of all Paradox's database and networking capabilities. Like all application building languages, though, it has distinct limitations.

First, PAL is an interpreted language, so some complex operations can take a considerable length of time. Second, there are some things that PAL just can't do. For example, if you were writing an electronic

point-of-sale system that worked with Paradox, it would be impossible to link the bar code reader directly with the database. An intermediate file would have to be created and processed at a later date.

To provide programmers with a solution to these problems, Borland have launched a C language interface to Paradox called the Paradox Engine.

## The Engine

The Paradox Engine is basically an applications programming interface (API) that allows, through a series of 70 function calls, direct access to Paradox tables and indexes.

The API allows you to create, read and write Paradox tables, records and fields. It provides support for password protection, encrypted tables, date encoding, searching and error handling. It can create and manipulate tables through serial communications, by downloading from mainframes, or from other external devices that cannot normally be reached by PAL.

It also provides network support with file, table and record locking. This means that both Paradox and Paradox Engine applications can gain access to a single table across a network without the integrity of the file being lost. The Engine, like Paradox itself, supports IBM Token Ring, Novell, 3COM, Banyan, Torus, AT&T Starlan and any other network that is 100% compatible with DOS version 3. The Engine applications can be run as stand-alone programs, or can be called directly from PAL using the RUN or, in most cases, the RUN BIG command. The API can be called from Turbo C, Microsoft C and, very soon, Turbo Pascal.

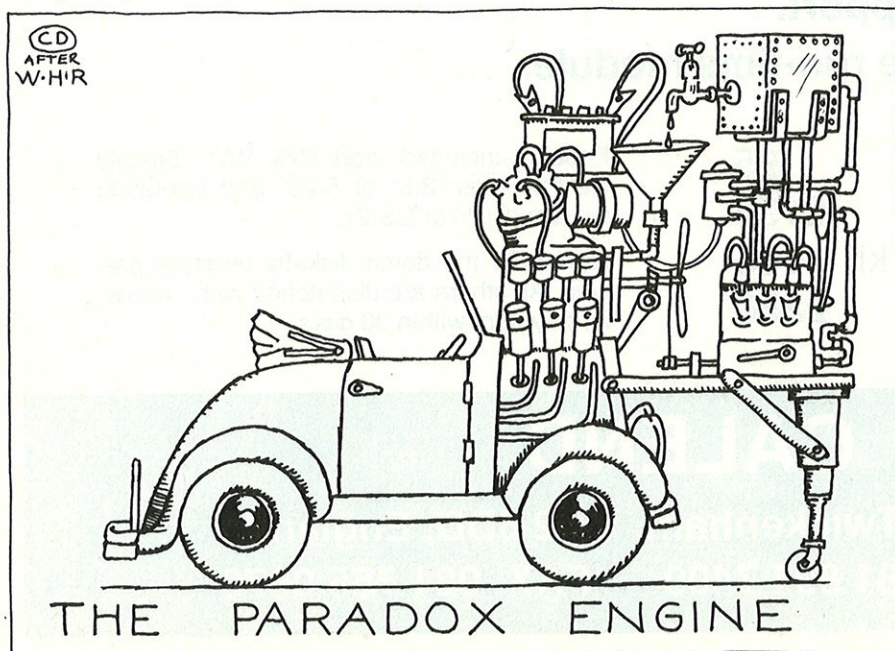
The Engine already forms the file control mechanism in two other Borland products - SideKick for Presentation Manager, and Quattro Pro. This allows Paradox, SideKick and Quattro to share files on a single server across a network.

Borland clearly sees this as an important element in its corporate strategy and are trying to make the Paradox file format a standard for network applications. The launch of the Engine so that other programmers can use it, makes an obvious contribution to this strategy. Nantucket have already announced that they will be including support for Paradox tables in Clipper 5.

## Installation

Like virtually all Borland's products, installation is simply a matter of typing `A:INSTALL`. After specifying the drive and directory where you want the Engine to reside, the library files and example applications are copied across.

Applications that use the Engine library can, at present, be written in Turbo C version 2.0 or Microsoft C version 5.1. For the purpose of this review, I tested that the Microsoft C compiler coped with the sample applications, but all serious testing was done using Turbo C.





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The two sample applications that are included with Engine provide an excellent reference for exactly how to write your own application - a detailed explanation of how they work forms the major part of the manual. My only criticism is that a Turbo C .PRJ or MAKE file was not included. This would have greatly simplified the task of getting the sample applications up and running.

The first example application is an ASCII Text to Paradox Table file conversion utility, while the second is a network phone directory called FONEDEX. The latter is actually quite a useful little application which, with the addition of a better front end, could make the basis of a neat network product. This program excellently shows how to pre- and post-process the raw data to make it suitable for Paradox tables to handle, and provides access to the basic error handling routines.

As well as the sample applications, a whole host of example files are included. These are simple programs that show, in a few lines of code, how to use one aspect of the Engine. The examples are also listed in the manual next to the relevant function reference. This not only allows for quick reference, but also provides a mechanism for

including working sections of code in your own programs.

Compiling an application with either Turbo or Microsoft C is performed in the normal way for each compiler, except that the large memory model must be specified. If you are using the Microsoft compiler, the default stack size must be increased. Currently, the Engine adds between 60 and 100 KB to the size of an application.

## The Engine in Use

Creating an Engine application is a fairly simple, if a little long winded, process. The function prototypes and data structures for the Engine are all in a single header file called PKENGINE.H which provides the four major global handles that the Engine uses - record, table, field and lock. It also includes #defines for the different modes and arguments required by various functions, thus making the final code a little more readable.

The first call is normally to the Engine initialisation routine PXInit, unless you are creating a network application when PXNetInit should be used instead. The only call that you can make before initialis-

ing the system is to get or set the default information about how the Engine should work.

In most cases, the defaults will be satisfactory, but there are still pitfalls to avoid. For example, if you use a copy of Paradox to create a table and an index, you will only be able to read the index providing the default settings for sort order are the same in your application as they were in Paradox.

Once the Engine has been initialised, you can begin the serious work of manipulating Paradox tables and indexes. To open a table, PXTblOpen is called. This requires a pointer to a table name, and a table handle. You can also indicate whether to use an index, if there is one, and whether or not changes should be saved as they are made or whether they should be stored until the table is closed. Then finally, a record buffer needs to be opened for the table. This is where the Engine keeps the current record and where the results of any search will be found.

A typical access to a Paradox table is shown in Figure 1. The program searches the database for record number 64 and then retrieves the data and prints it out. The

```
#include <stdio.h>
#include "pxengine.h"

RECORDHANDLE rechandle; /* record buffer */
TABLEHANDLE tblhandle; /* table handle */
FIELDHANDLE fldhandle; /* field handle */

const char *fname[2] = { "HROYALP.DB",
    "HDEMYP.DB" };

const char *fieldno[5] = { "Record-Number",
    "Field-2",
    "Field-3",
    "Field-4",
    "Field-5" };

int main(void); /* Prototypes */
int Error(int);

int main(void)
{
    int fileno=0;
    int record=64;
    int i;
    double tmp;

    if (Error(PXInit())) exit(1); /* Initialise engine */
    clrscr();
    Error(PXTblOpen((char *) fname[fileno], &tblhandle, 0, 0));
    Error(PXRecBufOpen(tblhandle, &rechandle));
    Error(PXFldHandle(tblhandle, "Record-Number", &fldhandle));
    Error(PXPutShort(rechandle, fldhandle, record));
    Error(PXSrchFld(tblhandle, rechandle, fldhandle, SEARCHFIRST));
    Error(PXRecGet(tblhandle, rechandle));
    for (i=1; i<5; i++) {
        Error(PXFldHandle(tblhandle, (char *) fieldno[i], &fldhandle));
        Error(PXGetDoub(rechandle, fldhandle, &tmp));
        printf("Field %d %4.0f\n", i+1, tmp);
    }
    return(Error(PXExit()));
};

/* Simple error handler */
/* Prints out Engine error message and returns */
int Error(int rc)
{
    if (rc != PXSUCCESS) /* Defined in header file */
        printf("ESTIMATE: Paradox Engine: %s\n", PXErrMsg(rc));
    return rc;
};
```

Figure 1 - Accessing a Paradox Table

### Initialisation and shut down

Functions to initialise and shut down system on both networked and stand alone machines. Also allows Paradox default information files to be loaded and saved.

### Table manipulation

Allows Paradox tables to be opened, closed, added to, copied, deleted, emptied, named and renamed. Also allows the table size, and whether or not the table exists, to be checked.

### Record manipulation

Allows records to be appended, deleted, loaded, inserted and updated. It also allows the new current record to be set to the first, last, next or previous record. Provides control of the memory resident record buffer.

### Field Manipulation

Allows the field type, handle and name to be set, and provides a mechanism for loading and saving each of the different field types.

### Index control

Provides a simple mechanism for adding and deleting indexes, and reindexing a file.

### Date control

Encodes or decodes a date from Paradox format to calendar format (day, month, year).

### Search operations

Allows a search of the index or the Paradox table itself.

### Password and security facilities

Provides password protection and encryption to tables.

### Informational operations

Gives access to the network environment information and the status of field, record and table handles.

### Network and Concurrency support

Provides network support with file, table and record locking.

### Error handling Operations

Full reporting of all errors through detailed messages.

Figure 2 - Main types of function provided by the Engine



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program works as follows. First, a field handle is assigned to a named field - `Record-Number`. A short integer is then put into the record buffer and a search is carried out. The record is then retrieved using `PXRecGet`. Then, by reassigning the field handle to the different fields in the record in turn, the data contained in the specific record, in this case four floating point numbers, can be retrieved from the record buffer.

One problem with this example is that the type and structure of the Paradox table must be known before the program runs. If the first field isn't a short, or isn't called `Record-Number`, the record will not be found. To enable unknown tables to be examined, the Engine provides a set of informational functions.

`PXRecNFlds` returns the number of fields in each record of the table, while `PXKeyNFlds` shows which of them is a key or indexed field. Using `PKFldType`, the field type can be ascertained. Now the correct type of `PXRecPut` and `PXRecGet` can be called. As you can see, everything is possible, eventually.

Like the functions that come with any C compiler, the way to see the Engine is as a set of building blocks from which you can make your own less verbose facilities. For example, I wrote a function called `TblSearch` that was called with a table handle, a record handle and a search structure. It then did all the necessary puts and gets, dealt with any error conditions and returned the answer in another structure. The functionality was the same, but the verbosity of the finished program was reduced completely.

## Speed

It's not easy to judge the speed at which an Engine application runs. As the Engine is initialised, it opens a buffer where it stores all its reads and writes. Unless specifically stated, the Engine will post-write most changes, and keep copies in memory of all the most recently read records. In a sample application I wrote, initialising the Engine, opening eight different files and searching for a number of items took less than a second. Writing the results of the test (approximately one tenth of the data) back to disk using a standard `fprintf`, took almost exactly the same time. This is a very fast file handler.

## Networking

Networking is so simple that it almost seems worth writing every application as

though it were going to run on a network. The only penalty is that the network handling routines add another 30 KB to the .EXE file size.

Basically, the only changes that need to be added are in the initialisation procedure and in any write/amend operations that are invoked. `PXNetRecLock` and `PXNetRecUnLock` are used to lock and unlock records when they are being modified across the network. If a file is only infrequently used by other users, table locking rather than record locking can be employed, because this is faster. Once that has been done, the application will run safely on any of the networks supported. I was impressed at how simple this was to achieve, and believe it will encourage developers who have shied away from networks to take another look.

## Documentation

The documentation consists of a single 250 page manual which covers installation, examples and reference. The reference and example sections are excellent, but I felt the introductory section could have explained more clearly how the Engine worked, and the reasons for the way in which it does things. A few words of the methodology used would have helped to alleviate the 'There *must* be a simpler way' feelings that were aroused in me every time I saw the list of functions I needed to call, even to achieve the simplest of things.

## Conclusion

My only real criticism of this package is the verbose list of function calls that are needed to do anything more complex than opening a table. When I put this to Phillipe Kahn, he commented that a 'higher level of interface' was in the pipeline. This would be a set of function calls that would shield the programmer, if he or she wanted to be shielded, from the mechanics of buffers and handles. A more typical 'search, and return with the answer' style of interface would be provided. Details of this new version are expected to be released at the Paradox Developers' Conference in Monterrey later this month. This also may account for the delay in launching the Pascal version of the product.

In general, this is an excellent product. It is a robust package that provides Paradox application developers with a powerful way of overcoming the limitations of PAL. It should allow application developers to develop more intelligent systems that can integrate with real world and real time events like scanners, bar code readers,

modems and other applications on networks and stand alone PCs. But the advantages don't stop there.

Imagine you were developing an application to run on a network. Wouldn't it be simpler if all the network file handling and contentions were handled for you? I used the Engine to write an application for Collins Publishing. It was a stand-alone application that accessed upwards of 20 tables. It then performed various calculations and manipulations of that data. If, tomorrow, Collins decide to run the application on a network instead of a stand-alone system, half an hour's programming would convert the application.

Not only is the Engine an excellent product for Paradox application developers, but it could also become an off-the-shelf solution to creating network specific applications. Borland have always wanted their file formats to become de-facto standards within the industry; selling a powerful networking engine that allows access by most levels of programmer could, perhaps, be the way of doing it.

**EXE**

*Andy Redfern worked as a writer for Personal Computer World Magazine, and is now a freelance journalist specialising in PCs and programming.*

### PRODUCT DETAILS:

#### Equipment required:

IBM PC, PS/2 or compatible  
512 KB memory (640 KB recommended)  
Hard disk  
DOS 3.0 or higher  
Turbo C V2.0 or Microsoft C V5.1  
Paradox V2 and V3 tables supported

#### Database Limitations:

Maximum 64 open tables  
256 KB maximum swap buffer  
128 KB maximum record buffer  
128 KB maximum file locks  
2 billion records per table  
255 fields per record  
4000 bytes per record (only first 1350 indexed)

#### Licenses:

Applications written using the Paradox Engine API have an unlimited, royalty-free run-time licence.

#### Manufacturer:

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**Price:** £325



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167	Jilly Juveniles	Wed Mar 29 1990	266.08		
173	Jilly Juveniles	Tues Apr 2 1990	987.96		
174	Jilly Juveniles	Tues Apr 3 1990	2581.03		
179	Jilly Juveniles	Fri May 22 1990	782.52	p	
186	Jilly Juveniles	Wed May 29 1990	555.22		
188	Jilly Juveniles	Thur May 30 1990	92.25	p	
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			566.22		4379.28

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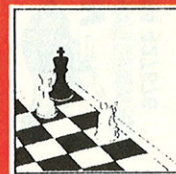
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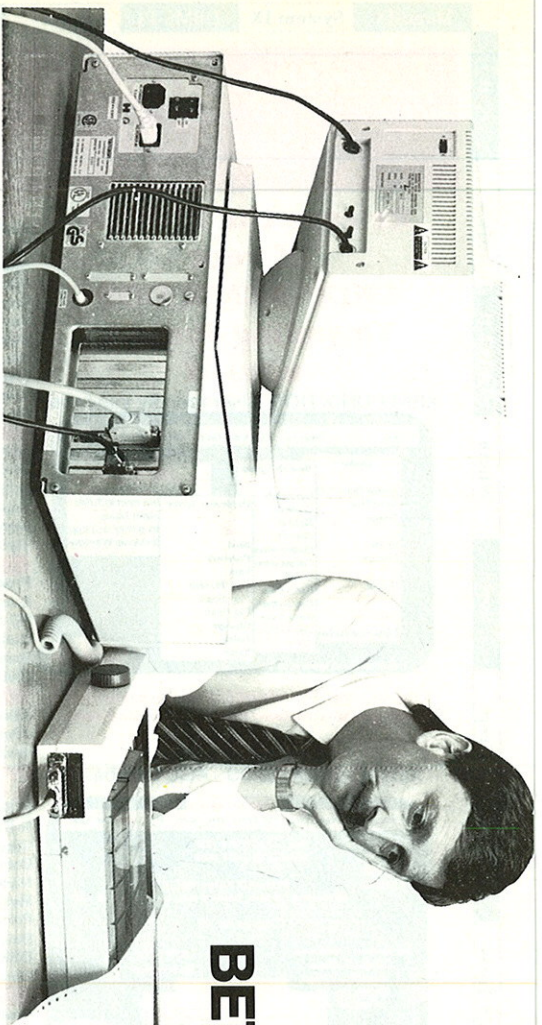
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# X-BUFFER FROM MICRO CONTROL SYSTEMS FOR ALL THOSE WHO'VE GOT BETTER THINGS TO DO WITH THEIR PC THAN WAIT FOR THEIR PRINTER

Imagine you've got a 30 page report on your PC. The average printer will take about 17 minutes to print out, during which time your PC is either completely incapacitated or operating far slower than usual.

So, what can you do?

With the MCS X-Buffer, lots.

WHY THE PROBLEM?

A printer operates at a slower rate than a computer, forcing the PC to wait whilst the printing job is completed. And with a plotter producing a complex CAD schematic, that could be several *hours*, not minutes. Fine if you've got time to waste—but most of us haven't.

WHAT IS THE X-BUFFER?

X-Buffer is an intermediate storage device that acts as an extension to the computer's own memory. It allows text or data to be downloaded in seconds and 'held' in the buffer ready to be fed to the printer at the correct rate.

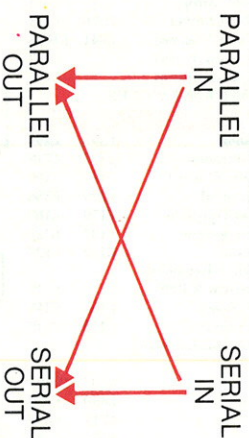
So there's no waiting for printing to finish, the PC is free to be used for other tasks.

In the case of your 30 page report, downloading to the X-Buffer would take around 28 seconds, leaving you 16½

minutes to get on with something far more constructive.

## VERSATILITY

Until recently printer buffers had to be specified according to the type of PC and the printer used and the interfaces each had. The X-Buffer is designed for maximum flexibility and incorporates four interfaces: RS232 Serial i/o and Centronics parallel i/o.



The interfaces can be used simultaneously so the buffer can be used in a variety of ways. Two computers sharing one output device (printer, plotter, modem). One computer driving two devices. Two computers using two devices.

## EXPANDABILITY

The X-Buffer is also easily expandable by the user, plug-in memory modules offering from 64K to 4 Mbytes of buffer memory.

That's not only good news for users but great news for dealers too — instead of holding large stocks of varying fixed capacity buffer units, the X-Buffer modules allow custom configuration depending on the users' needs.

## EXTRAORDINARY VALUE

And the price of the X-Buffer is probably the best feature.

**FROM**  
**£159**

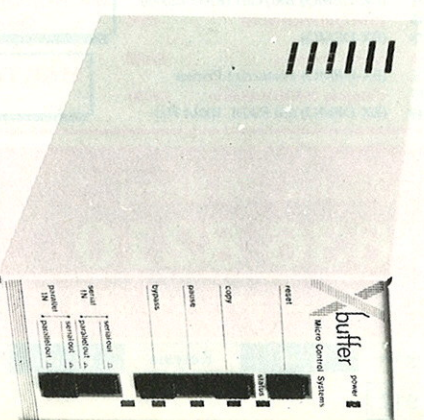
The 64K basic unit costs a mere £159 RRP including a standard two year parts and labour warranty.

X-Buffer from Micro Control Systems. Don't let your printer (or plotter or modem) keep you waiting.

The X-Buffer is just one of a range of buffer products manufactured and supported in the U.K., available from Micro Control Systems. Tel: 0602 391 204

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# Hardware Focus

*Our regular look at recent hardware launches, as they affect software developers.  
This month, networks and PS/2s dominate.*

## PS/2 Range Expands

IBM expanded its PS/2 range at the end of March with the launch of six new computers and a collection of peripherals.

There are four new Model 80s, and two versions of the new Model 65. All the new machines are Micro Channel based, and have SCSI hard disks. It's the first time that IBM's PCs have had SCSI interfaces as standard.

Also announced was a new 14 inch colour monitor.

The Model 80/A31 has a 25 MHz 386, four 32-bit slots and four 16-bit slots. There is a 64 KB cache, 4 MB of RAM as standard (expandable to 8 MB on board, or 16 MB in total), and a 320 MB SCSI hard disk with an access time of 12.5 ms. The Model 80/A21 is the same, but with a 120 MB SCSI disk. The SCSI controller can support up to four SCSI hard disks. Prices are £7831 and £6267.

The Model 80/M21 is a 20 MHz 386 machine, with three 32-bit slots and five 16-bit slots. With a 320 MB SCSI disk it costs £6978. The Model 80/X21 is the same, but with a 120 MB SCSI drive, and costs £5271.

The Model 65/SX 121 has three 32-bit slots, and five 16-bit slots, and runs a 386SX at 16 MHz. It has 2 MB of RAM and a 120 MB SCSI drive, and costs £4101. The 65/SX 061 is the same, but with a 60 MB SCSI hard disk, and costs £3545.

A PS/2 MCA SCSI card, available separately for other PS/2 machines, costs £363 for a 16-bit version, or £717 for the 32-bit version with cache. The SCSI drives (320 MB, 120 MB and 60 MB) are £3890, £1367, and £854.

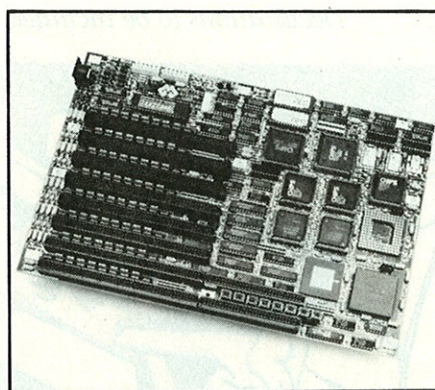
IBM has also entered the world of CD-ROM. The internal version for a PS/2 costs £893, and you'll also need an .89 adaptor kit. An external drive costs £1069. This, we can't

help noticing, is around five times the price of similar drives that we've seen.

Finally in this batch of announcements, there's an entry level Model 70, a new laser printer with optional PostScript capability and the new 8515 colour monitor.

## New Motherboards

Monolithic Systems Corporation is an American hardware manufacturer. According to the dictionary, monoliths are massive



and unmoveable, which makes it all the more surprising that MSC have produced a couple of neat 25 MHz 386 motherboards for those who want to build or distribute PCs. The 386CT is the baby-AT version, with eight slots, while the 386CX is the grown-up version with 14. The boards use a Chips & Technologies chipset, and an AMI BIOS. Prices are £1100 for the CT with 2 MB of RAM, and £1370 for a similarly configured CX. A 25 MHz 486 board is also available now. This has eight slots, and costs £2100 when populated with 2 MB. UK distributor is Micro Marketing, which sounds a much more suitable name, who are on 06285 29222.

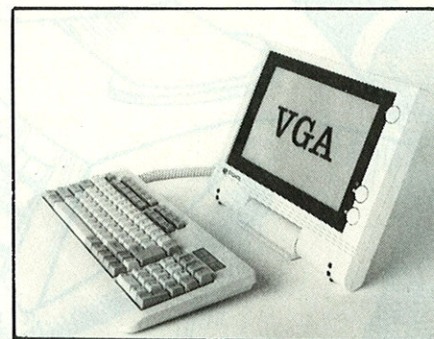
## Instant Networks

CompuAdd is about to launch what the Company likes to call an 'off-the-shelf' net-

work. Bristol-based CompuAdd are putting the finishing touches to 4-user and 8-user network starter packs, aimed at small companies and software development teams. Each kit comprises Novell software and Ethernet hardware, and a CompuAdd 286 or 386-based server. The price, which has not yet been announced, will include cabling and testing. Installation and training services are also available. Installing a single PC is hard enough; installing four of them, and networking them together, is often too complex for end users. CompuAdd's solutions sound like an ideal way to ease the load of a consultant, who can now offload the purchasing and installation to the client, and concentrate instead on configuring the system and writing bespoke software.

## LCD VGA

If your desk is so cluttered that you've had to buy a special wheel to exercise your mouse, or you suffer from eye strain when staring at a standard monitor, then you may be interested in a possible solution. It's a high contrast, black and white VGA monitor, based on LCD rather than a CRT. It's 6 cm thick, weighs two kilos and costs £695. Not cheap, but rather good looking. UK



distributor, in case you want to call them and ask what the keyboard in the photo is for, are Sygnos Technologies. They can be reached on 01 352 1478.

EXE



## Supporting Dual Monitors

*This month's Code Page explains how to connect two monitors to a PC simultaneously, and send different data to each.*

Before we start, an apology. In the .EXE office, we tend to use the OPTASM assembler, because it's faster than MASM. Also, it has the amazingly useful feature of allowing conditional jumps that are out of range. At assembly time, it translates these jumps into code that the CPU can accept. In the past, OPTASM code has crept into the Code Page listings. So, if you've tried to assemble programs, only to have MASM say that conditional jumps are out of range, the necessary corrections should be obvious. If they're not, call the office.

Now to dual monitor support under MS-DOS - the subject of this month's Code Page feature. Many thanks to Bob Stimpson for the contribution.

When IBM decided that the PC should be capable of supporting more than one installed monitor by making the video memory start addresses generally unique, it gave the machine an ability that few have fully exploited. Autocad and CodeView are two

current examples from the minority of major vendor software which has used this capability to the full. To the vast majority of programs, however, this remains uncharted territory. For debugging of programs, especially those that normally run in a

```
DECLARE FUNCTION MDAHIBYTE% (Value AS INTEGER)
DECLARE FUNCTION MDALOBYTE% (Value AS INTEGER)
DECLARE FUNCTION MDATWOBYTE% (HiValue AS INTEGER, LoValue AS INTEGER)
DECLARE FUNCTION MDACURROWCOL% ()
DECLARE FUNCTION MDAOK% ()
DECLARE FUNCTION MDASCREEN% (Row AS INTEGER, Col AS INTEGER, Mode AS INTEGER)
DECLARE SUB MDALOCATE (Row AS INTEGER, Col AS INTEGER)
DECLARE SUB MDACURSIZE (StVal AS INTEGER, EndVal AS INTEGER, Mode AS INTEGER)
DECLARE SUB MDAPALETTE (Mode AS INTEGER)
DECLARE SUB MDAPRINT (Printed AS STRING, Attribute AS INTEGER)
DECLARE SUB MDASCROLL (StLine AS INTEGER, EndLine AS INTEGER, Mode AS INTEGER)
```

*Declarations to be included in the calling BASIC program*





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## System Science

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Fax: 01-837 6411

CIRCLE NO. 915

## USING INFORMIX?

The E.I.U.G. is an independent non-profit making group of Informix users which acts as a forum for the exchange of information, ideas and experiences. We publish an informative newsletter and hold regular meetings for members. Our next meeting is on the **17th May 1990** in central London.

*For further details contact*

*Bryce Campbell on 0532 738244  
or Jenny Russell on 081446 6481*

## EUROPEAN INFORMIX USERS GROUP

Informix is a trademark of Informix Software Inc.

CIRCLE NO. 917



## Listing of MDASETB.ASM

```

; MDASETB.ASM contains source code
; for the assembler routines called
; by the MDA access routines in
; QuickBASIC. MASM v5.0 syntax has been
; used for directives.

; These routines are intended to
; demonstrate the ease with which the
; MDA can be accessed from a language
; ostensibly only able to support one
; monitor.

; For these routines to run correctly,
; the PC must be set up with the colour
; monitor as the default on boot-up and
; the quick language invoked using this
; colour monitor. For environment work,
; it is recommended that MDASETB.ASM be
; compiled into a Quick Library and the
; /L [libraryname] command line switch
; is used to load it.
; Eg, QB /L MDASETB.QLB.

.MODEL MEDIUM
.CODE

PUBLIC MDAHIBYTE
PUBLIC MDALOBYTE
PUBLIC MDATWOBYTE
PUBLIC MDACURROWCOL ;Returns csr col/row
PUBLIC MDACURSIZE ;Sets or hides csr
PUBLIC MDALOCATE ;Positions cursor
PUBLIC MDAOK ;Finds MDA card
PUBLIC MDAPALETTE ;BLINK control
PUBLIC MDAPRINT ;Prints to MDA screen
PUBLIC MDASCREEN ;Returns char or attr
PUBLIC MDASCROLL ;Scrolls or clears MDA
;screen

MDAHIBYTE PROC
PUSH BP ;set up stack frame pointer
MOV BP,SP
MOV BX,[BP+6] ;get BASIC argument address
MOV AX,[BX] ;load into AX
MOV AL,AH ;put high byte in AL
XOR AH,AH ;clear AH
POP BP ;restore stack
RET 2 ;exit
MDAHIBYTE ENDP

MDALOBYTE PROC
PUSH BP ;set up stack frame pointer
MOV BP,SP
MOV BX,[BP+6] ;get BASIC argument address
MOV AX,[BX] ;load into AX
XOR AH,AH ;clear AH
POP BP ;restore stack
RET 2 ;exit
MDALOBYTE ENDP

MDATWOBYTE PROC
PUSH BP ;set up stack frame
MOV BP,SP
MOV BX,[BP+8] ;get BASIC HIGH BYTE
;argument address
MOV DX,[BX] ;load value into DX
MOV BX,[BP+6] ;get BASIC LOW BYTE
;argument address
MOV AX,[BX] ;load value into AX
MOV AH,DL ;load high byte into AH
POP BP ;restore stack
RET 4 ;exit
MDATWOBYTE ENDP

MDACURROWCOL PROC
MOV DX,3B4h ;select MDA 6845 CRTC
;address port 3B4
MOV AL,0Eh ;address register 0E
; (cursor high byte)
OUT DX,AL ;activate CRTC
INC DX ;select CRTC data port 3B5
IN AL,DX ;get cursor high byte
MOV AH,AL ;move high byte to AH
DEC DX ;select CRTC address port 3B4
MOV AL,0Fh ;address register 0F
; (cursor low byte)
OUT DX,AL ;activate CRTC
INC DX ;select data port
IN AL,DX ;get cursor low byte
;AX now contains cursor pos
MOV BL,50h ;load characters per row (80)
DIV BL ;divide AX by BL:
;cols now in AL, rows in AH
XCHG AH,AL ;inc, to use BASIC offset
INC AH ;instead of CRTC zero offset
RET ;return with data in AX
MDACURROWCOL ENDP

MDACURSIZE PROC
PUSH BP
MOV BP,SP ;set up stack addressability
MOV BX,[BP+6] ;get Size control
MOV AX,[BX] ;put value in AX
OR AX,AX ;is it = 0?

JZ SHORT HideSize ;hide the cursor
MOV BX,[BP+10] ;get START variable
; address from stack
MOV AX,[BX] ;put variable in DX

CMP AX,0 ;row less than zero?
JB SHORT CursizeExit ;error- so exit
CMP AX,13 ;is start row > 13?
JA SHORT CursizeExit ;error -so exit
MOV CL,AL ;store start in CL
MOV BX,[BP+8] ;get END variable
; address from stack
MOV AX,[BX] ;put variable in AX
CMP AX,0 ;row less than zero?
JB SHORT CursizeExit ;error- so exit
CMP AX,13 ;row more than 13?
JA SHORT CursizeExit ;error -so exit
MOV CH,AL ;store end in CH

Setsize:
MOV DX,03B4h ;load MDA address reg value
MOV AL,0Ah ;activate CRTC
OUT DX,AL
INC DX ;address CRTC data register
MOV AL,CL ;load low cursor size byte
OUT DX,AL ;send to CRTC
DEC DX ;load MDA address port value
MOV AL,0Bh ;load size high
OUT DX,AL ;activate CRTC
INC DX ;address CRTC data register
MOV AL,CH ;load high cursor size byte
OUT DX,AL ;send to CRTC

CursizeExit:
POP BP ;clean up and exit
RET 6

HideSize:
MOV CL,20h ;set invisible
;positions for start
MOV CH,20h ;and end cursor size
;locations
JMP SetSize ;now drive the CRTC
MDACURSIZE ENDP

MDALOCATE PROC
PUSH BP ;set up stack pointer
;addressability
MOV BP,SP
MOV BX,[BP+8] ;get addr of ROW value
MOV AX,[BX] ;move row count into AX
DEC AX ;correct for zero offset
CMP AX,0 ;check for valid row
JB SHORT ExitLocate ;if below 0, exit
CMP AX,24 ;if above 24 exit
JA SHORT ExitLocate ;if above 24 exit
MOV BL,80 ;set up for chars per row
MUL BL ;multiply AX by BL
MOV CX,AX ;save result in CX
MOV BX,[BP+6] ;get address of COL value
;in BASIC
MOV AX,[BX] ;move col number into AX
DEC AX ;correct for zero offset
CMP AX,0 ;check for valid col
JB SHORT ExitLocate ;if below 0, exit
CMP AX,79 ;if above 79, exit
JA SHORT ExitLocate ;if above 79, exit
ADD CX,AX ;add columns, row total for
;full offset
MOV DX,3B4h ;select CRTC address
MOV AL,0Eh ;address cursor high byte
OUT DX,AL ;activate MDA CRTC
INC DX ;address data port 3B5
MOV AL,CH ;put high byte cur pos in AL
OUT DX,AL ;send to CRTC
DEC DX ;select address port 3B4
MOV AL,0Fh ;address cursor low byte
OUT DX,AL ;activate MDA CRTC
INC DX ;select data port address 3B5
MOV AL,CL ;low byte of cur pos in AL
OUT DX,AL ;send to CRTC

ExitLocate:
POP BP ;restore segment pointer
RET 4 ;return with 4 bytes of args
MDALOCATE ENDP

MDAOK PROC
MOV DX,03B4h ;load MDA address reg value
MOV AL,0Eh ;load cursor high reg value
OUT DX,AL ;activate CRTC
INC DX ;address CRTC data register
IN AL,DX ;get current high byte value
MOV AH,AL ;save in AH
MOV AL,37h ;set AL to arbitrary value

OUT DX,AL ;send to CRTC
JMP MdaReady1 ;wait for CRTC to respond

```

graphics environment such as Windows, twin monitors are essential - a colour monitor runs the graphics environment, while a mono monitor displays debugging information.

It could be said that there are not many users currently with operational dual-monitor systems or hardware - and until quite recently this was probably correct. There is an accelerating acceptance of VGA and EGA displays for the now standard 80286 and 80386 based machines. As these drop in price and existing users upgrade to better monitors, there will be an increasing number of surplus MDA monitors widely available. These are currently so cheap, that it's well worth getting hold of one.

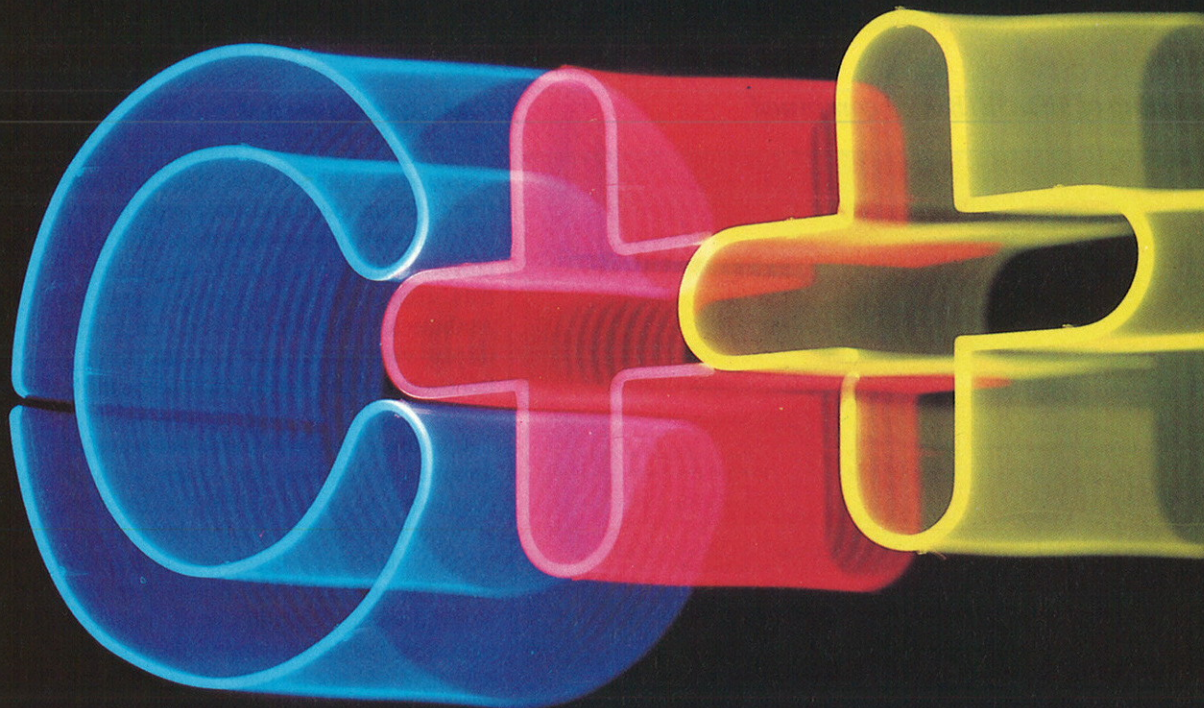
Two displays double the amount of data presented to the user - so it is the program designer's increasing responsibility to ensure the system is presented in a consistent and ergonomic manner. It becomes very easy to create twice as much junk display output with two monitors, and this may easily succeed in confusing the user to a far greater extent than simply by a factor of two! This needs to be borne in mind if you are thinking of writing some dual-display software.

## Tools

The object of this article is to provide the reader with tools to evaluate the benefits of dual-monitor systems. Writing directly to video memory is one solution to the problem of addressing two monitors, but it must be done using assembler, otherwise it is grossly inefficient and the screen changes will be slow and discernable. In considering how to approach the overall problem, I decided that the simplest approach was the best - leave the graphics/colour monitor control to the experts who produced my Microsoft language compiler, and I would provide a library to control the MDA.

The routines presented here interface directly with Microsoft QuickBASIC or BASIC 6.0. Thus the assembly language interface expects arguments passed by near reference. The BASIC strings must be stored in DGROUPE (the default) for these demo routines to function - hence the requirement for only the offset to the start of the string and not also the segment. Strings are passed by reference to a BASIC string descriptor (four bytes). The first word of the descriptor is a two-byte integer describing the length of the string, and the second word is the near offset to the start of the string. For C programmers this should not prove a problem - the routines can be easily modified to suit your own preferences or calling mechanism if you need wider versatility.





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CIRCLE NO. 918



## Listing of MDASET.B.ASM continued

## Gaining Control

The primary operations needed for effective control of the MDA are: checking/confirming it is installed and initialised; clearing a display viewport on the screen; setting the character display attributes; displaying a data string; returning a character code or attribute at a specific location; scrolling a display viewport up one line; maintaining full control of the cursor size and location.

These functions can be further subdivided down into detailed operations, such as operations to write a string of text with attribute bytes inserted within it, or write a string of plain text using a separate attribute byte. The approach here has been to provide the simple, straightforward, minimum consistent with a working evaluation system. It would not be difficult to add other routines which emulated specific language commands or DOS interrupts if needed.

The structure of the routines and functions presented here has been organised to provide the programmer with the most straightforward method of accessing the MDA from a DOS programming environment. The most frequently used display commands have been emulated to provide an effective method for MDA control.

It is important to note that these demonstration routines contain only the most elementary error checking code - for an operational library, the error trapping must be improved to your own in-house requirements.

## Preparation

To use these routines, the assembler routines should be entered and assembled using MASM 5.0 or above to an object file. Using LINK with a command line such as: LINK /Q MDASET.B.OBJ, MDASET.B.QLB, BQLB40.LIB; will create a Quick library which can be loaded into the QuickBASIC environment when invoking it by including the command /L MDASET.B.QLB on the QB invoking command line. The QuickBASIC program can then be entered and the assembler routines accessed directly. To compile into a .EXE file from within the environment, you must first produce a library file by invoking LIB with the instructions

```
LIB MDASET.B.LIB+MDASET.B.OBJ;
```

Without this file, the QB compiler will abort stating 'library file not found'.

## The Routines in Detail

The presence of an MDA in the system is verified by MDAOK which returns a value

```
MdaReady1:
JMP MdaReady2 ;(these take 20 or 30 clocks,
;depending on CPU)

MdaReady2:
IN AL,DX ;load current setting
XCHG AH,AL ;place original in AL
OUT DX,AL ;restore original value
MOV BL,AH ;save in BL
XOR AX,AX ;clear AX for return
;MDAOK = false
CMP BL,37H ;are set and read
;values the same?
JNE SHORT BadMDA ;no - return with AX = 0
MOV AX,1 ;yes an MDA - so
;return with AX = 1

BadMDA:
RET
MDAOK ENDP

MDAPALETTE PROC
PUSH BP ;set up stack pointer
;addressability
MOV BP,SP
MOV BX,[BP+6] ;get address of PALETTE
MOV AX,[BX] ;move into AX
CMP AX,1 ;if palette 1, set the
;blink bit
JE SHORT SetBlink
CMP AX,0
JNE SHORT SkipPalette ;error - so exit
MOV DX,3B8h ;disable blink
;address CRTC register
MOV AL,00001000b ;blink bit(5) in AL
;control byte = 0
OUT DX,AL ;send to CRTC
JMP SHORT SkipPalette ;error

SetBlink:
MOV DX,3B8h ;enable blink
;address CRTC register
MOV AL,00101000b ;blink bit (5) enabled
OUT DX,AL ;send to CRTC

SkipPalette:
POP BP ;restore stack pointer
RET 2 ;return
MDAPALETTE ENDP

MDAPRINT PROC
PUSH BP ;set up stack frame pointer
MOV BP,SP
PUSH ES ;save registers which will be
PUSH SI ;changed
MOV DX,3B4h ;select MDA 6845 CRTC
;address port 3B4
MOV AL,0Eh ;address register 0E
;(cursor high byte)
OUT DX,AL ;activate CRTC
INC DX ;select CRTC data port 3B5
IN AL,DX ;get cursor high byte
MOV AH,AL ;move high byte to AH
DEC DX ;select CRTC address port 3B4
MOV AL,0Fh ;address register 0F
;(cursor low byte)
OUT DX,AL ;activate CRTC
INC DX ;select data port
IN AL,DX ;get cursor low byte
;AX now contains pos
SHL AX,1 ;double to get byte offset
MOV DI,AX ;load as destination offset
MOV BX,[BP+8] ;get string descriptor addr
MOV CX,[BX] ;load string length into CX
JNZ ErrorExit ;if it is a null string,exit
MOV SI,[BX+2] ;load offset of string
MOV AX,0B000h ;load MDA segment into
MOV ES,AX ;ES for addressing
;the video memory
MOV BX,[BP+6] ;address of attribute byte
MOV AX,[BX] ;load value into AX
MOV AH,AL ;put attribute byte into AH

PrintString:
MOV AL,[SI] ;place string char into AL
INC SI ;SI to next char.
MOV ES:[DI],AX ;move char and attr to
;MDA video mem
ADD DI,2 ;inc to next char posn
LOOP PrintString ;transfer until CX = 0

ErrorExit:
POP SI ;restore registers
POP ES
POP BP
RET 4
MDAPRINT ENDP

MDASCREEN PROC
PUSH BP
MOV BP,SP
MOV BX,[BP+10] ;get address of ROW
MOV AX,[BX] ;move row count into AX
DEC AX
CMP AX,0 ;check for valid row
JB SHORT ExitScrn ;if below 0,exit
CMP AX,24
JA SHORT ExitScrn ;if above 24 exit
MOV BL,160 ;bytes per row
MUL BL ;calc word offset
MOV CX,AX ;save result in CX
MOV BX,[BP+8] ;get address of COL
MOV AX,[BX] ;col number into AX
DEC AX
CMP AX,0 ;check for valid column
JB SHORT ExitScrn ;if below 0, exit
CMP AX,79
JA SHORT ExitScrn ;if above 79, exit
SHL AX,1 ;get byte offset
ADD CX,AX ;full offset
MOV BX,[BP+6] ;get address of Mode
MOV DX,[BX] ;load value into DX
PUSH DS
PUSH SI
MOV AX,0B000h ;MDA seg addr
MOV DS,AX ;load SI with offset
MOV AX,CX
MOV SI,AX ;save flags
PUSHF
CLD
LODSW ;DS:[SI] into AX
POPF
POP SI
POP DS
CMP DL,0 ;if 0, then (AL) wanted
;so don't move
;character value
;it's not 0, so
;attribute wanted
JE SHORT ExitScrn

ExitScrn:
XOR AH,AH ;AH not needed
POP BP
RET 6 ;return 6 bytes of args
MDASCREEN ENDP

MDASCROLL PROC
PUSH BP ;set up stack pointer
;addressability
MOV BP,SP
MOV BX,[BP+10]
MOV DX,[BX] ;put variable in DX
DEC DX ;correct for zero offset
CMP DX,0 ;start row less than zero?
JB SHORT ScrollExit ;error- so exit
CMP DX,23 ;start more than 23?
JA SHORT ScrollExit ;error - so exit
XCHG DH,DL ;store start in DH
MOV BX,[BP+8] ;get END variable addr
MOV AX,[BX] ;put variable in AX
DEC AX ;correct for zero offset
CMP AL,DH ;less or equal to start?
JLE SHORT ScrollExit ;error - so exit
CMP AL,24 ;end row off screen?
JA SHORT ScrollExit ;error - so exit
MOV DL,AL ;store end in DL
MOV BX,[BP+6] ;scroll ctrl val addr
MOV AX,[BX] ;put value in AX
CMP AX,0 ;is it = 0?
JE SHORT ClearAll ;is it = 1?
CMP AX,1 ;scroll up 1
JE SHORT ScrollUp1 ;error, so exit

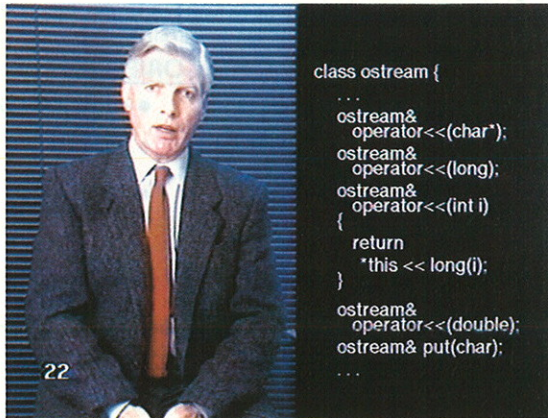
ScrollExit:
POP BP ;clean up and exit
RET 6

ClearAll:
XOR AX,AX ;clear AX to calc clear
;start offset
MOV AL,DH ;load AL with start line
MOV BX,160
MUL BL ;start offset in AX
MOV CX,AX ;save in CX
XOR AX,AX
```



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## Listing of MDASET.B.ASM continued

```

MOV AL,DL ;load AL with end line
SUB AL,DH ;subtract start line
INC AL ;get true size in lines
MOV BX,80 ;number of chars per row
MUL BL ;multiply to get size

;of area in AX
MOV BX,CX ;put offset in BX
MOV CX,AX ;CX as number of words

ClearBlock:

PUSH DI ;save ES:DI register pair
PUSH ES
MOV AX,0B000h ;MDA segment value into ES
MOV ES,AX
MOV DI,BX ;get offset from BX
PUSHF ;save flag status
CLD ;clear direction flag
MOV AX,0007h ;load AX with null char
CLI ;halt interrupts
REP STOSW ;move word in AX to ES:DI
;CX times, incrementing DI
;restore interrupts
STI
POPF
POP ES ;restore register values
POP DI
JMP ScrollExit ;finished - so exit

ScrollUp1:

XOR AX,AX
MOV AL,DH
INC AL
MOV BX,80 ;mult by 80 chars/row
MUL BL ;start offset in AX
SHL AX,1 ;get byte offset
MOV CX,AX ;move to CX
XOR AX,AX

MOV AL,DL ;load AL with end line
SUB AL,DH ;subtract start line
MOV BX,80 ;multiply to get
;size of scrn area AX

MUL BL ;save offset in BX
MOV BX,CX ;load in CX as words
PUSHF ;save flag status
PUSH DI ;save ES:DI values
PUSH SI ;and DS:SI
PUSH ES
PUSH DS
MOV AX,0B000h ;put MDA segment B000
MOV ES,AX ;into ES
MOV DS,AX ;and DS
MOV AX,BX ;get start offset from BX
MOV SI,AX
SUB AX,160 ;calc port start line
MOV DI,AX ;load DI as scroll dest
CLD ;clear direction flag
CLI ;halt interrupts
REP MOVSW ;move word in DS:SI to
;ES:DI for CX times
;restore interrupts
STI

POP DS
POP ES ;restore register values
POP SI
POP DI
POPF ;scroll complete
;bottom port line
XOR AX,AX ;clear AX to calc
;offset of base line
MOV AL,DL ;lower line value in AL
MOV BX,80 ;characters per line
MUL BL ;mul to get offset in AX
SHL AX,1 ;get byte offset
MOV BX,AX ;save in BX
MOV CX,80 ;number of words on line
JMP ClearBlock ;jump out
MDASCROLL ENDP
END

```

of one if it finds an MDA and zero if it does not. (Example: IF MDAOK% THEN PRINT "MDA FOUND"). MDAOK checks for the presence of the MDA by attempting to address one of the two registers on the CRTC.

It first reads the current cursor high byte from register 0Eh. It then sets a new byte (arbitrarily here at 37h) and then reads what it has just set. If the written and read values agree, then it is safe to assume an MDA is present. MDAOK takes a total of 100 clock cycles to complete this activity, the cursor being misplaced for 50 of these cycles.

MDASCROLL is the most complex of the routines presented here. The first two arguments are the top row and bottom row of a screen window which is to be processed. The contents are scrolled up one line, or cleared, according to the value of the third argument. The scroll is the full width of the screen.

Writing a string to the MDA is handled by MDAPRINT which takes as its arguments a BASIC string descriptor and an attribute byte. The string is written to the screen at the current cursor location. The string can be any length (other than a null string). (Example: MDAPRINT (FRED\$, 7) .)

The movement of string data from one part of memory to another for scrolling has been achieved using the REP MOVSW mnemonic. This may not at first seem sensible -

but the only reason why it is not used in other routines published elsewhere is because they have to take into consideration

## For debugging Windows programs, twin monitors are essential

the need to drive a CGA, and overcome the accompanying 'snow' interference problem. This does not exist on the MDA, so I felt quite free to use the fastest possible method available.

The MDA cursor size is controlled by MDA-CURSIZE which will also conceal the cursor if required. (Example: MDACURSIZE (startline%, endl ine%, visibility) Visibility is one or zero.)

The cursor can be concealed from view by setting the character cursor lines to non-displayable values. The MDA character size is 14 by nine pixels. The most reliable method conceals it by setting both the start and end values for the cursor lines to 20h. Setting just the high byte may have unpredictable

results, so your routine should set both bytes. This requires access to a write-only CRTC port. If you want to refer to the value you are writing to this port, save it elsewhere as a variable. DOS does this for the cursor size on the default monitor system by updating the bytes at 00460h and 00461h with the low (start) and high (end) values.

MDALOCATE positions the cursor on the screen. (Example: MDALOCATE X5, Y%).

MDACURROWCOL returns the current row and column positions of the MDA. (Example: PRINT MDAHIBYTE% (MDA-CURROWCOL%) will print the cursor row, while PRINT MDALOBYTE% (MDACURROWCOL%) will print the column).

Closely akin to these routines is MDA-SCREEN which returns either the ASCII code or attribute byte for a specified screen character location. (Example: PRINT CHR\$ (MDASCREEN% (1, 1, 0)) returns the character at 1,1, and PRINT HEX\$ (MDASCREEN% (1, 1, 1)) returns the attribute.)

The final routine is MDAPALETTE which provides two similar sets of text attributes by enabling or disabling the blink bit in the MDA Mode Control register. (Example: MDAPALETTE 0, or MDAPALETTE 1). When enabled, blinking text can be displayed on the screen. When this bit is zero, blinking is disabled and the attribute value then controls the intensity of the background attribute.

MDAPALETTE accesses the CRTC Control Register 03B8h, to enable or disable blinking text. This register is also used by the Hercules mono graphics card, so you must ensure that, if you are using one, the HGC is in text mode before invoking this routine. If a Hercules card is present in your PC for evaluation of these routines, it defaults to MDA mode ('DIAG' in Hercules terminology) on boot-up. If this is not done (details in many Video guides or the Hercules manuals) setting these bytes at zero for an MDA will change the HGC without changing other registers, thus damaging the display physically. The above precaution is, therefore, only applicable if the Hercules graphics card has been in graphics mode before these demonstration routines are invoked.

EXE

Bob Stimpson is a Chartered Engineer who initially started finding out how things worked by dismantling his father's wrist-watch at the age of five. Unfortunately the wrist-watch didn't work again for 'technical' reasons.



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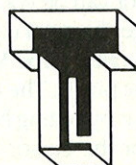
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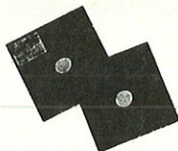
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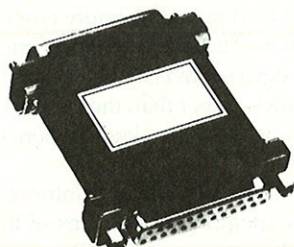
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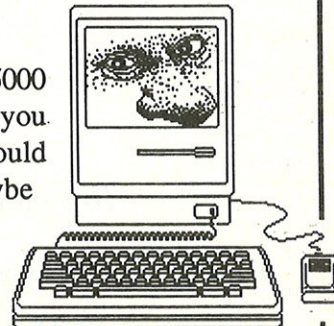
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# Books

*This month, two books for PC developers and one for FoxPro programmers.*

## PC File Formats and Conversions

A long time ago, John Wiley published two books. One was called 'File Formats for Popular PC Applications', and the other was 'More....'. These books explained the file formats used by Lotus 1-2-3, WordStar 3.3 and a number of other, now-obsolete, applications.

Ralf Kussmann's book, unlike the others, is not simply a collection of reference tables and lists. Instead, it's a collection of easily-readable chapters that explain file formats, and how to convert data between similar applications.

The formats which are fully documented are dBASE IV, IBM DCA/RFT, Microsoft SYLK and Microsoft Word 4.0. The explanations of how to transfer data, cover Pagemaker 3.0, dBASE IV, DisplayWrite 4 V2.0, 1-2-3 V2.2, Freelance Plus V2.01, CHART V3.0, Excel V2.0, Multiplan V4.0, Word V4.0 and V5.0 and Ventura V2.0. The explanations don't include full documentation of the file format - instead, there are details of how to use one application to produce data that is readable by others. Often, there's nothing more involved than clicking an option on a menu. Other times, however, there are macros to write, margin settings to check and so on.

The utility programs and macros listed in the book, as well as an SDF-to-ASCII translator written in Turbo Pascal, are all included on a disk, which accompanies the book.

If you're trying to write conversion utilities, then this is probably not the book you're looking for. However, if you want to know how to convert files using the facilities built into the applications you already have, this is going to be handy to have around. If you can't get hold of a copy, you can order one from Computer Manuals who are on 021 706 6000.

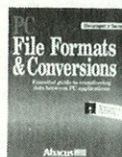
*Author: Ralf Kussmann*

*Publisher: Abacus*

*Price: £32.45*

*ISBN: 1-55755-059-X*

*Pages: 290*



## PC System Programming

The .EXE shelves are bursting with books that give you a guided tour around the insides of your PC. In our time, we've probably criticised them all. Most of them aren't technical enough. Few dare to mention undocumented DOS areas and data structures. Some cover just DOS and ignore the BIOS. Some cover only the BIOS and ignore DOS.

PC System Programming, on the other hand, ignores hardly anything. It's a superb reference and tutorial on how to do low-level fiddling with just about every part of the PC system. There are dozens of sample programs, in a mixture of Turbo Pascal and assembler (C freaks will have to think back to the days before they saw the light). If you can't face typing in the listings, then there's a pair of disks enclosed (for £55, I suppose, there had jolly well better

be).

The first chapters deal with software interrupts - what they are, and how to call them from various languages including GW-BASIC (yes, really), Turbo Pascal and C. Then, in no particular order, come discussions of the interrupt controller chip, the clock, the disk controller, the structure of a device driver and the insides of DOS V4.0. Next comes undocumented DOS structures which explains the workings of memory control blocks, the DOS Info Block and others. The DIB is a table of internal DOS lists, and provides access to device drivers, the system file table (which lets you find the names, rather than the handles, of open files) and so on. Did you know that, if you know where to look, you can find the interleaved value of your hard disk?

Other chapters include information on determining the amount of free memory, discussions of floppy disks, hard disks, keyboards and printers, writing TSR programs, programming all sorts of video cards and the real time clock, accessing EMS memory, mouse programming and determining the CPU type. There's even a complete DOS and BIOS call summary.

If you are programming MS-DOS PCs at a low or medium level, you'll find this book rapidly becomes indispensable. There's a huge amount of information in it, and you'll be amazed how often you'll find things you didn't know. For a book so large, the index is fairly small, but the chapters are small and easily scannable. If you can find a spare couple of inches on your bookshelf, fill them with a copy as soon as you can. Computer Manuals, who distribute Abacus books in the UK, will ship you a copy if your local shop don't have any.

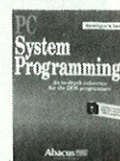
*Author: Michael Tischer*

*Publisher: Abacus*

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*Pages: 930*



## FoxPro Made Easy

This is just one of the large number of FoxPro books that are beginning to fill the .EXE shelves. Unlike some, this is definitely not just a dBASE book that's been through a search-and-replace operation on a word processor. It explains how to use all of FoxPro's features, including the mouse and windows. Despite the title, this book is more for programmers than end-users, and includes a thorough summary of all FoxPro's commands and functions. A very good introduction, especially as the FoxPro manuals themselves don't attempt to teach the basics of programming.

*Author: Edward Jones*

*Publisher: Osborne/McGraw-Hill*

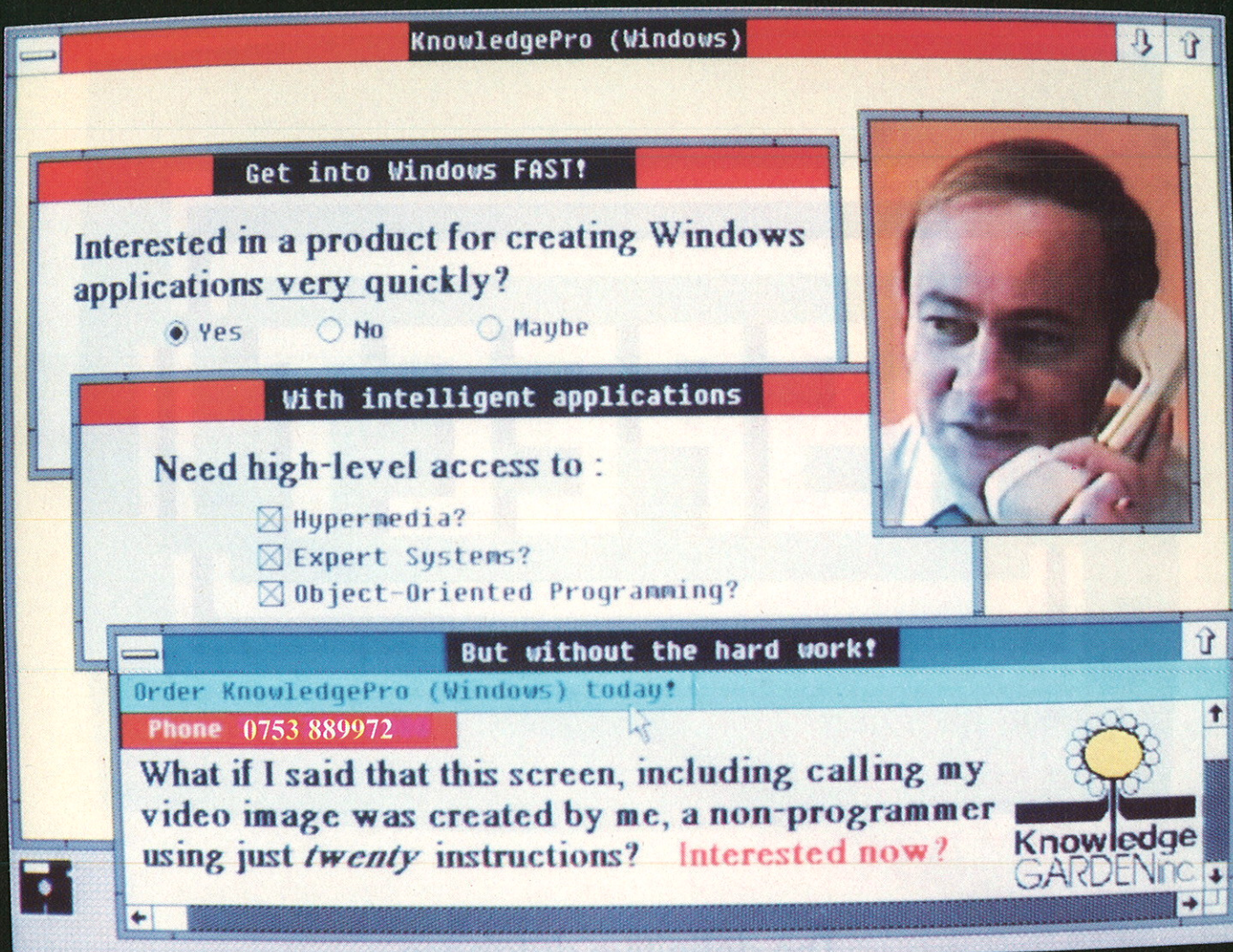
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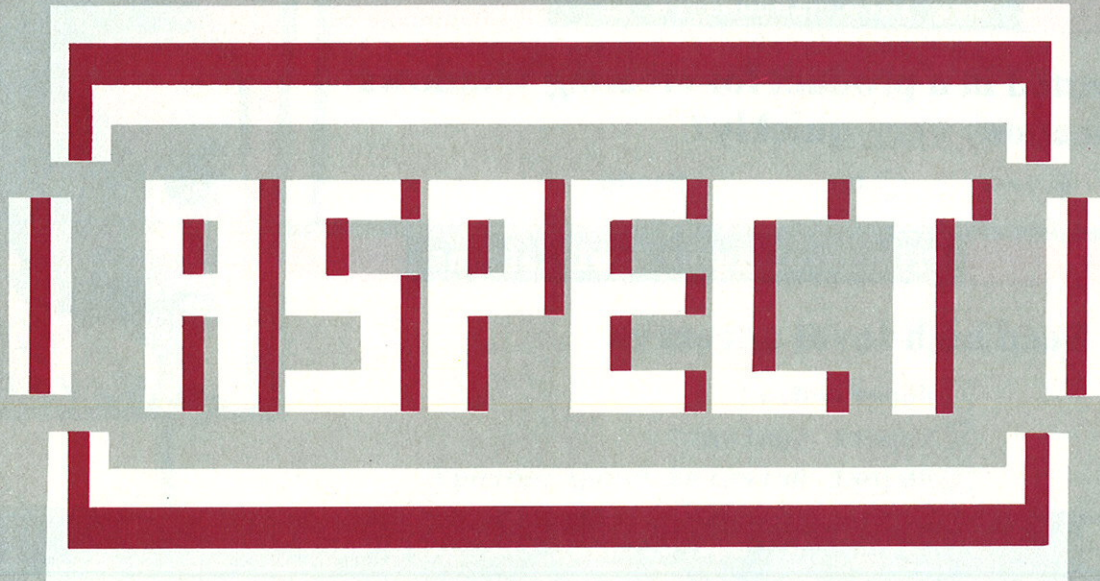
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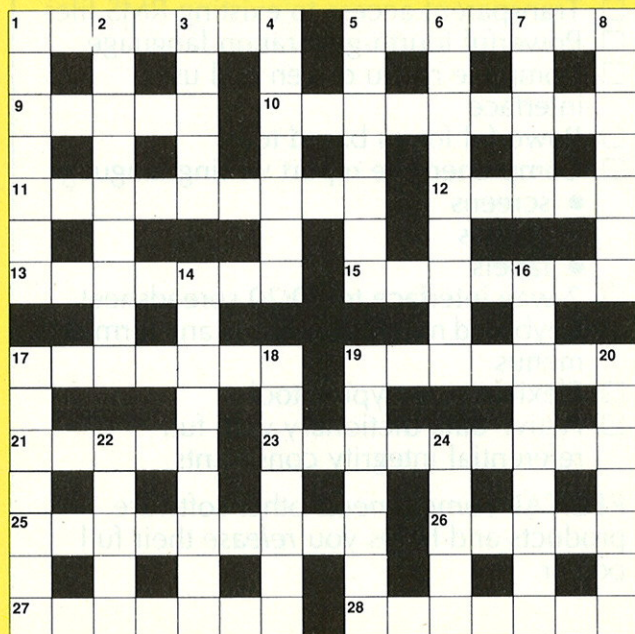
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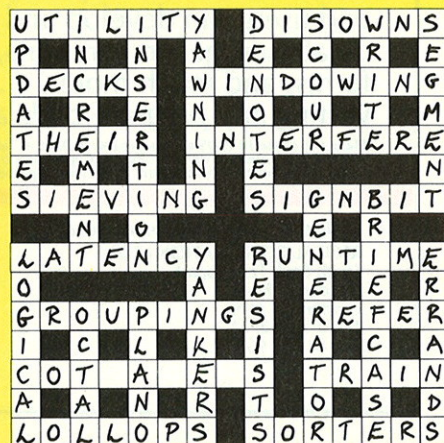
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### CLIPPER ANALYST – PROGRAMMERS

Intelligent, articulate analyst-programmers required by small central London software company set on expanding our successful PC banking system.

We program in Clipper backed by C and Assembler and need to produce a C version and port it to Unix and other operating systems. We use generators and software tools extensively and are implementing OOP techniques as they become available.

Science graduate preferred, with at least 2 years Clipper experience in networked banking or accounting applications. C, Unix or Assembler an advantage, curiosity and imagination an asset. Must be presentable and able to deal with clients when required. Initially, must be able to cope with supporting old products under pressure as well as working on exciting new projects from scratch. A mature attitude and understanding of business issues is essential.

The prospects are as good as you are and an exciting range of opportunities is available to the right person. Progression into either pure development or management is wide open.

Starting salary £18,000 to £20,000 depending on experience and ability.

We also have opportunities for trainees.

Please write enclosing CV to Trish McNamara at:

**Synchronicity Ltd., Suite 103, City View House,  
463 Bethnal Green Road, London E2 9QH**

### SOFTWARE – C/UNIX UK TO 25K

#### REAL TIME

Berkshire  
16k

Software engineers required to carry out design, development and implementation of software or systems RT applications, 2-3 years experience ideally in a defence environment. Sound working knowledge of C, VAX-VMS and/or SUN UNIX operating systems is essential.

#### SIMULATION/MODELLING

Sussex

Intermediate and senior software engineers required, ideally with experience in Real Time Simulation using C and Assembler, to work on advanced simulators and training systems.

#### SENIOR SOFTWARE ENGINEERS

Berkshire  
To 18k

Degree in Electronics, Computer Studies, Physics or related discipline with 2 years experience of embedded software design. A knowledge of high-level languages such as Ada, Pascal or C needed for design and implementation of Communications applications.

#### COMMUNICATIONS

Sussex

Software engineer required to develop communications interfaces to other manufacturers' products and systems and new networking protocols. Requires experience of at least one of the following:- Datacommunications protocols, Ethernet/Arcnet, C, Z80 Assembler or X25.

#### SYSTEM SUPPORT PROGRAMMER

Essex  
To 20k

To provide technical support to a range of UNIX machines including VAX 500 and SUN 3 servers and workstations, working as part of a systems support team. Candidates should have a sound familiarity with UNIX support systems and an interest in a career in systems support.

#### PARALLEL PROCESSING – Hard/Software

West Country

Engineers required with good hardware and software skills at device and system level. Technologies include RISC processors, high speed ASIC's with device and system level software in C using a UNIX based operating system.



Send a CV in complete confidence or telephone.

33 Staple Gardens,  
Winchester,  
Hants SO23 8SR

Tel: 0962 69478

Eve/Weekends: 0962 760241

Fax: 0962 841982



# REAL-TIME SOFTWARE DEVELOPMENT FOR INTERNATIONAL TELECOMMUNICATIONS

**SENIOR SYSTEMS ENGINEER**

**SE LONDON**

**TO £20,000 + BONUS**

Our clients are long-established specialists in the telecommunications/ACD marketplace, currently developing a range of sophisticated real-time systems.

Based in a high-tech business park, the success of its ACD, call management, ISDN and interactive voice and data systems has resulted in spectacular progress in recent years.

Recent expansion has resulted in the requirement for a senior systems engineer to assume a high level of project responsibility in the development of the latest state-of-the-art software.

Four years' computing with upwards of two years' real-time experience is required, using high-level block-structured languages such as 'C', Pascal and 680X0 assembler in a UNIX, OS9 or similar environment. Good interpersonal skills are required for the large amount of client liaison the post will involve.

This is an excellent opportunity to join a highly successful company offering an outstanding career in leading edge technology. International travel is envisaged. The remuneration package includes a profit-related bonus with regular salary reviews.

**For a confidential discussion please call David George**

**071-409 2844**



6th Floor, Empire House, 175 Piccadilly, London W1Z 9DB

Telephone 071-409 2844 Fax: 071 629 1801

Offices in London and Los Angeles

## Recruiting for Today's Technology

*Given the enormous potential of technology throughout the 1980s, how can we accept the mere 8% growth in productivity? Steve Standring believes that it is time we addressed recruitment issues in a planned and systematic approach.*

The centralised IT department is rapidly becoming obsolete. Within five years, I believe that 40-50% of the new jobs in IT will be in new roles. Today, the general trend appears to be moving more towards users and away from 'techies' and programmers. If this trend continues, then eventually the man who writes the requirement definition will also create the system - a scenario which implies that a radical change in values and orientations is required.

To get the most out of today's technology, new organisational structures have to be implemented. In fact there has to be a total rethinking of structures and skills based on future technology and business issues. We need to manage multiple organisation structures and different recruitment processes.

Not everyone is going to have the new skills for the jobs available, so rewarding people for jobs and skills is critical. Breaking the skills deficit cycle is going to require both more investment and a managed process.

Building and organising IT for the future requires a systematic approach. Initially we are seeing the need to assess an organisation's base preparedness to implement new technologies and to make change happen. We then need to design and plan for the IT structure of the future; the only way in which we can do this is by re-orienting the IT recruitment practices to implement these

changes. The key to this is going to be the development and management of one's employees.

The new environment will require a wider perspective and a new emphasis away from technical skills and more towards business skills. Both IT and people working in IT will have to align themselves still further, ensuring that the business is run on a basis which is planned and understood by all participants.

In order to create complete cohesion between the IT staff and the business, we are going to see personnel/'human resource' management being dynamic, progressive, nurturing and supportive. This requires a non-hierarchical organisation and careful planning, of which there are five stages: Planning, Requirement Analysis, Design, Construction and Development/Maintenance. Only by concerted attention to the whole process can we place the correct candidate in a position appropriate to them, thus maximising efficiency and effectiveness.

Companies must no longer simply accept what is offered by external recruitment sources and must develop a relationship with a consultancy who feels part of the business solution, and who feels responsible for the business problem.

*Steve Standring is Senior Executive of Computer People's Business Consultancy Division.*



# SOFTWARE DEVELOPERS

## OXON

£15k - £20k

'C' Experience either under DOS or UNIX is required to develop and support insurance and financial software on SUN workstations, incorporating an AI facility. C++, OS/2 or Windows experience an added advantage.

## BUCKS

£14k - £25k+

Leading geophysical analysis and simulation consultancy currently developing state of the art software, 3D Graphics, Relational Databases and HCI is seeking professionals with at least one of the following: 'C'/UNIX, 2D/3D Graphics, Fortran or Databases.

## KENT

to £22k

Numerate graduate calibre staff sought by resources company with either 'C', Fortran or Assembler to develop applications for Vector Processing, Array Processors and Graphical Devices.

## CAMBS

£15k - £25k

World renowned leader in Digital Cartography and Geographical Information Systems seeks software professional with 'C'/UNIX expertise to interpret satellite information into Interactive Graphics and Spatial Databases. Any knowledge of Image Processing, Fortran or VAX/VMS experience useful.

## SCOTLAND

£15k - £25k

Windows and 'C' experience is required, hopefully with a good mathematical background, to develop simulation and modelling software for fluid flow.

## SOUTH COAST

£15k - £25k

Leading designer of advanced instrumentation Control Systems is keen to recruit 'C' and UNIX skills. Any experience of: C++, x-Windows, SQL, TCP/IP, Decnet or IPSE useful. Working on relational databases, graphics and communications. Full training and 'open door' management style.

## ITALY

£19k - £23k

Remote Sensing and Satellite Imaging systems developer is seeking a skilled software engineer with Pascal on VAX/VMS with either SUN/UNIX or PC's under MS-DOS. Oracle, Database or Comms experience useful.

## MIDDX

£14k - £25k

Analyst/Programmers sought to develop Project Management Software in 'C' and UNIX. Any experience of VAX, SQL or Oracle would be an added bonus for this fast growing progressive organisation.

## SURREY

£15k - £22k

Programmers and Analysts needed to develop insurance applications. You should have in-depth knowledge of one or more of: 'C', Prolog, Informix, Oracle, SQL, UNIX or MS-DOS

## BERKS

to £21k

Specialist in Image Management/Document Retrieval Systems seeks software engineers with 'C'/UNIX and any of: SUN Workstations, Graphics, Raster/Vector or X-Windows experience. Includes requirement specification, Systems Design, programming and support.

## DORSET

£15k - £22k

Skilled and imaginative software engineers with skills in C under UNIX are sought to develop the next generation of advanced engineering systems. Working on SUN workstations you will be creating Graphics User Interfaces, Compilers and System level drivers for special purpose hardware.

## LONDON

£15k - £25k

One of the fastest growing suppliers of multi-user financial systems is seeking a talented person to lead their bespoke development on SUN / UNIX. Informix essential, SQL, Ingres, 4GL, Cobol or 'C' useful.

### MANY MORE INTERESTING POSITIONS THROUGHOUT THE U.K!

Contact us to find out more about these posts or the many others that we have. As specialists in the industry, we can provide you with a professional and confidential service in assisting you with the right career move. Telephone or write to one of our consultants.

**081-392 1514**

ACUMEN SEARCH & SELECTION INTERNATIONAL  
No 7, Tideway Yard, Mortlake High Street, London SW14 8SN  
Tel: 44 (0)81 1514 Fax 44 (0)81 1518

**Evenings till 9pm 081-878 8206**



**ACUMEN**

SEARCH & SELECTION  
INTERNATIONAL

## SOFTWARE ENGINEERS Oxfordshire

RCP is a software house specialising in high quality custom software for PCs and other microcomputers. We are now seeking further skilled staff, preferably graduates with up to 3 years relevant experience, to join our development teams working on interesting projects in a number of different areas, including:

- networked terminals incorporating expert systems techniques for international banking;
- graphics products for financial analysis;
- instrument control, data logging and image analysis for non-destructive testing;
- manuscript tracking for journal publishing;
- National Curriculum record keeping for schools.

You will typically be working in a small team developing software in C or C++ under a variety of operating systems such as DOS, Microsoft Windows, OS/2 or Unix and will have the satisfaction of complete involvement with a technically demanding project from specification through to delivery.

Company benefits include a friendly and attractive working environment, six-monthly salary reviews and a profit-sharing scheme.

To apply please send your CV to:

**RCP**

Chris Jobson  
Richards Computer Products Ltd.  
Dales, High Street  
Didcot, Oxfordshire OX11 8EQ  
Tel: 0235-510116

## Retrain to 4GL's and Unix

### West End

£ good

Market Research Company in West end are seeking someone with a high degree of numeracy, and a knowledge of any Relational database. Training where necessary will be provided on their systems (Unix, 'C', Informix). This is an ideal position for someone seeking a career move into Unix and Relational databases/4GL's.

### PC Programmers

#### All areas

to £25,000

Programmers of all levels urgently required by our clients in London and the home counties. A minimum of 18 months experience in C is essential plus one or more of the following: MS DOS, OS/2, Unix, MS Window, X Windows, SQL, or CAD. Call us now to find out more about these excellent opportunities.

### dBase/Clipper

#### S.W./N. London

to £20,000

Two of our clients based in SW. London and N. London respectively are currently looking for high calibre programmers with good knowledge of dBase III+/Clipper and/or Foxbase. Any experience with Novell networks would be an advantage. If you fit the bill and are looking to make a good career move call us now!

### Trainers

#### London & Watford

to £17,000 + Car

We have immediate vacancies for computer literate trainers to develop, maintain and deliver courses. Familiarity with various PC packages and good keyboard skills essential. Experience of Unix, Sculptor or Payroll desirable. Preferably a car driver as some UK travel will be involved.



22 Bloomsbury Square, London WC1A 2NS  
Tel: 071-580 2355 Fax: 071-636 9170



## TRAINERS

**Salary = £18-20k + Car**  
**Position = Uniplex Trainer**  
**Location = Buck/Berks**

Our Clients who are major Software Houses and training companies presently require 4 additional trainers to run and develop training courses within the Uniplex application. You must have proven skills to a configuration level coupled with good classroom lecturing skills. In return you can expect an excellent package with good career prospects.

**Salary = £23-27K + Bonus + Car**  
**Position = Training Manager**  
**Location = Berks**

Unix based distributor presently require a Unix Training Manager to expand and develop the training department into a profit based unit. You must have a technical background within the Unix and Informix market and at present be established as a Training Manager or Senior Lecturer.

THIS IS JUST A SMALL SELECTION OF THE VACANCIES ON OUR FILES. IF YOU REQUIRE FAST AND EFFICIENT ASSISTANCE IN MAKING YOUR CAREER MOVE, CALL NOW ON 01-258 1878 (24 HOURS) OR SEND YOUR CV TO JOHN YOUNG

95 YORK STREET . LONDON W1 H 1DU . TEL 071 258 1878 . FAX 071 724 5617

## SUCCESS BREEDS SUCCESS

Hickson Timber Products Limited (part of the Hickson International Group of Companies), are acknowledged world specialists in the field of timber treatment technology, and a major supplier of timber preservative chemicals and decorative finishes to the building supplies industry.

Our outstanding record of growth and future planned expansion, has now created this KEY POSITION.

### ANALYST PROGRAMMER

**West Yorkshire** **c.£14,000 + excellent benefits**

This is a period of significant change as a major project has commenced to replace our current financial and order processing systems, with an HP 9000 Series running under an HP-UX (UNIX) operating system. The use of PC based packages is also being expanded throughout the Company.

Reporting directly to the Senior Systems Analyst, the successful applicant will be involved in a wide range of roles within a small DP department. On a personal note, you should also have a sound business mind, as your decisions will have a long term impact on our operations.

Educated to at least 'A' level standard, you must demonstrate 2-3 years experience in a commercial environment, have UNIX and COBOL programming skills and be able to communicate with users at all levels. If you have knowledge of LOTUS 123 and WORDPERFECT, then that would be advantageous.

In return for your commitment, we are offering a salary of c.£14,000, 26 days annual holiday, profit-related bonus, pension and life assurance schemes. Relocation expenses will be considered where applicable.

If you want to be part of our success and in turn increase your own career prospects, please write with full c.v., or telephone TODAY for an application form and further details to:  
Martin Thomson, Personnel and Training Manager, Hickson Timber Products Limited, Wheldon Road, Castleford WF10 2JT. Telephone Castleford (0977) 556565 ext. 2244.



(7150)

## WEST YORKSHIRE

Programmers (COBOL, 'C', BASIC and 4GLs), Analyst Programmers, Software Engineers, Project Leaders, Support (pre and post sales), Trainers (MS-DOS, UNIX and Applications). Also Hardware/Software Design Engineers.

### FOR YOUR NEXT CAREER MOVE AROUND WEST YORKSHIRE:

Telephone Vincent Atherton on Leeds  
(0532) 504560 or write to:

## AIREDALE RECRUITMENT

Realtex House, Micklefield Lane.  
Rawdon, Leeds LS19 6AX

**AIREDALE  
RECRUITMENT**



# Connections

## PERMANENT LONDON

### RECRUITMENT CONSULTANT - OTE £25,000 PLUS CAR

IT Connections are expanding and are seeking to recruit two more consultants for their W1 office. Ideally you will have at least six months IT recruitment experience preferably in a PC environment. Further training will be given where appropriate. We have excellent working conditions, regular advertising, and a custom built database. A good sense of humour is essential. For more information please contact Mike Oakes on 01 753-0160 or 01 467-6149 evening and W/Ends.

### JUNIOR BUSINESS ANALYSTS - £16,000 + BENS

Minimum one years experience as an analyst preferably with PC skills. Excellent opportunity to progress in a 'greenfield' environment within the Insurance industry.

### PC SUPPORT - WEST LONDON - £18-21,000 PLUS BANKING BENS

QS/2 Lan server experience essential. Very exciting and responsible position in State Of The Art environment.

### 2 X PC - DEVELOPERS - £16-22,000 - W. LONDON

Household name company requires dBase/Clipper skills in a Novell environment for new systems development. UNIX training available.

### MICROVAX VMS PC SUPPORT - c£16,000 PLUS BENEFITS

This international bank based in the City are looking to recruit good VMS experience with a general knowledge of PCs. Training will be given in PC Software where appropriate.

## MIDDLESEX

### PC ANALYST - £15-20,000 + BENS

In the first instance this will be a support/evaluation role progressing later into a development role as well. You will be evaluating database products for future use. Novell, Excel and MS-Word useful but not essential.

### LAN SPECIALIST - TO c£19,000 + BENS

Large State Of The Art end-user requires Token-Ring LAN skills, SNA and OS/2 interest would be useful and you will be working on new State Of The Art systems development.

### LAN/WAN SUPPORT - TO £17,000 + CAR

Networking specialist required for pre/post sales support and configuration. Novell and comms experience an advantage but not essential. Friendly atmosphere.

## HANTS/DORSET

**PC-DATABASE DEVELOPMENT - c£17-20,000 + BANKING BENEFITS**  
2 x PC-Analyst/Programmers required for new systems development. PARADOX, DBASE, FOXBASE, etc., experience required. Excellent opportunities in progressive bank.

### 3 X PC SUPPORT/DEVELOPMENT - TO £18,000 + BANK BENS

Bournemouth and Basingstoke available for PC Support and PC Development roles. Experience of Paradox, Foxbase and/or dBase/Clipper required.

### LAN SUPPORT - BASINGSTOKE - TO c£12,000 + CAR

Experience of Novell and/or PC LAN required for total solutions company. Experience of Accountancy systems an advantage but not essential.

## AVON/WILTS

### 2 X PC SUPPORT - c£16,000 + BENS

Swindon and Bath positions available with household name companies. Knowledge of Novell and Lotus 123 required. Large LAN/WAN installations so Connectivity training on offer.

## BERKS

### PC SYSTEMS (ACCOUNTS) ANALYST - c£15-18,000 + BANK BENS

Household names financial services company urgently requires people with Accounts background and PC experience eg. Lotus 123, Symphony etc. for support/development role.

### PC SUPPORT - SLOUGH - TO c£16,000

Experience of Novell, Smart DW4 etc. required for this ideal 1st or 2nd jobber position. Good career move.

## BUCKS

### 2 X PC-SUPPORT (DEV) - HIGH WYCOMBE AREA - c£14,000 + BENS

Large end-user urgently needs two support personnel at prestigious new offices. Experience of TOKEN RING/PC-LAN NETWORKS, LOTUS 123, DW4, DBASE and 3270 emulation experience an advantage, but not essential.

## OXON

### 2 X PC - DEVELOPERS - c£16,000 + RELOCATION

Essential requirement for professionals at household name company to work with 'C' in a PC/Workstation and OS/2 R+D environment.

## SUSSEX

### PROJECT LEADER - SUB MORTGAGE - TO £21,000

Project leading skills essential for this position. You will be dealing with "EMERGING TECHNOLOGY" (Touchscreen Technology). Knowledge of C will be required, plus a good general knowledge of PC Hardware and Software.

## MILTON KEYNES

### PC DEVELOPMENT - TO £18,000

Good education plus dBase III + skills required for this consultancy. Very good corporate career growth.

### CLIPPER PROGRAMMER - TO £18,000

Clipper programming skills required for Blue Chip company. Good opportunity to progress in this large I.T. Division.

## SURREY

### 3 COM EXPERT - c£22,000 + CAR

Excellent 3 Com Networking skills required for this specialist consultancy. Good promotional prospects envisaged ie. full consultancy.

### SENIOR ANALYST PROGRAMMER FOXBASE OR DB3 - £21,000 + BENS

Excellent Foxbase or DBase skills required for this Insurance Company based in Surrey. Minimum 3 years experience programming. Analytical skills also essential.

## BIRMINGHAM

### PC SUPPORT - TO £15,000

Excellent opportunity for a person with at least 18 months experience in a support environment to join a consultancy committed to excellence. You must have skills in Lotus 123 (macro level) and DBase 3+ (Development Level) Good promotional prospects.

## HERTS

### DEVELOPMENT + SUPPORT

### NOVELL + CLIPPER - TO £16,000

CLIPPER + NOVELL skills essential for this number 2 position. Training given where necessary in other packages.

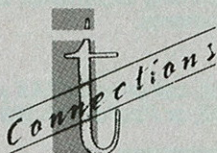
### DBASE III + OR FOXBASE - TO £15,000

Knowledge of dBase III + or Foxbase required for a software solution company. Opportunity to progress quickly in challenging environment.

## CLIENTS

IT CONNECTIONS is rapidly becoming the number one Recruitment Consultancy for PC Support and Development personnel. If you as a client are currently recruiting or expect to in the near future, then please call us now with your requirements in order that we may tailor our advertising to your needs.

I.T. CONNECTIONS  
160 NEW BOND STREET  
LONDON W1Y 0HR  
TELEPHONE: 071-753 0160  
FAX: 071-753 0162



# THAMES VALLEY

## SOFTWARE/DESIGN ENGINEERS

### SURREY

**£20,000**

Our Client specialises in the design of electronic and computer systems, data acquisition data analysis, simulation and complex interfacing. They are expanding and seek graduate Engineers with the ability to write drivers, knowledge of screens and user friendly attractive software skills. Experience of 'C', UNIX, PASCAL, FORTRAN, OCCAM is essential.

## ANALYST PROGRAMMERS

### MIDDLESEX

**£18,000**

Our client's central skills are the design and development of computer applications and digital and analogue electronics. Do you have a Computer Science or equivalent degree, with a minimum of 3 years experience in ADA, CORAL, PASCAL, C, YOURDON, MAS-COT, JACKSON, within a real time environment. If you do they offer the opportunity to develop your career with one of the UK's leading engineering organisations.

## HARDWARE/SOFTWARE ENGINEERS

### SURREY

**£18,000**

Our Client, who provides complete computer system solutions for defence and civil markets, currently seek highly motivated engineers to work on a variety of technically demanding projects. A degree in a scientific discipline with experience in any of the following is required: FORTRAN, CORAL, PASCAL, ADA, ASSEMBLER.

## SYSTEMS ENGINEERS

### SURREY

**£18,000**

This small, rapidly expanding Computer Systems Design Company, specialising in graphics and image processing, seek candidates with experience of 'C', UNIX, OCCAM, PASCAL, ASSEMBLER to work on exciting projects utilising state of the art technologies. Candidates should possess a technical honours/good HND.

**To find out more about these and many more exciting career opportunities please call LYNNE HOUGHTON on 0932 244014 (office hours) or 0784 247982 (eves/weekends).**

## THAMES VALLEY COMPUTER APPOINTMENTS

Franklin House

Station Approach

Shepperton

Middlesex TW17 8AN

TEL: (0932) 244014 (24 hours)

FAX: (0932) 253476



# TECHNICAL SOFTWARE OPPORTUNITIES

## 'C'/DOS

**Surrey to £19,000**  
This rapidly expanding organisation who provide computer based automation and management systems to the TV industry are recruiting software engineers with 18 months' experience of 'C', 68000, MS-DOS or OS/9. Any knowledge of the broadcast industry, Yourdon Design methodology or Ethernet communications would be useful.

## Graphics

**Cambridge to £18,000**  
Our client is a world leader in the field of geographic information systems and terrain analysis and visualisation. They require young engineers with a good degree and at least 12 months' experience in graphics with 'C' on VAX or UNIX. This is an excellent opportunity to develop your career with an expanding company in an exciting business.

## OCCAM and 'C'

**London to £18,000**  
A very successful software house, specialising in the development of financial systems for the city are expanding their team of software engineers. The systems are based on arrays of transputers, and if you have 2 years' experience of 'C' and OCCAM you are likely to be of interest.

## 'C'/Comms

**London to £22,000**  
We are recruiting on behalf of a technical systems house involved in the communications, financial and electronic industries. They are looking for young, bright, outgoing, software engineers with at least 2 years' experience in 'C', Ada or Pascal in an MS-DOS/UNIX environment, together with some exposure to object oriented design and data communications.

## MS-DOS/Windows

**M4 Corridor to £22,000**  
This company has an excellent reputation for quality in all aspects of their business. The systems development group is no exception. They need analysts programmers and senior analysts with skills in 'C', MS-DOS and MS-Windows to develop Point of Sale systems. Good salaries and benefits are offered in a new, high-tech business environment.

## C/UNIX - Technical Support

**Hants to £23,000**  
Personable individuals with in-depth UNIX skills are required by this manufacturer, to take responsibility for technical support of their workstation products. 'C' and UNIX are essential, and any assembler or understanding of hardware would be an advantage.

## 'C' + 4GL's

**Hants to £21,000**  
Our client is an expanding systems company involved in both the defence and commercial sectors. They require good software engineers with 2 to 3 years' experience in 'C', UNIX, Informix and Ingres. Any exposure to structured methodologies (JSD, Yourdon, SSADM), or EPOS systems would be advantageous.

## 'C'/UNIX Development

**West Surrey to £20,000**  
This software house develops turnkey systems for the airline and telecommunications industries. If you have skills in 'C' (or similar), UNIX or Stratus, you are likely to be of interest. Knowledge of communications would be an added advantage. There is no 'bodyshopping' with this company.

## 'C'/8086, Real-Time

**Herts to £17,500**  
This company specialises in the development of multimedia video systems incorporating sophisticated graphics and complex software development techniques. If you have good real-time skills using 'C' and assembler on either PCs or Macintosh call us now.

Towers Recruitment, Chiltern Chambers  
St. Peters Avenue, Caversham,  
Reading RG4 7DH  
Tel: 0734 461200  
Fax: 0734 461137



TOWERS RECRUITMENT

To apply for any of the above positions call Lisa Edey or Robin Wiltshire on (0734) 461200 (24 hours) or write to Towers Recruitment, Freepost (RG1604), Reading, RG4 7BR, enclosing brief career details or your CV. The positions advertised represent a small percentage of our total vacancies. Of you are working in technical computing, but cannot see your ideal jobs/location in this advertisement, please contact us by telephone or send a CV.

## PC Engineer/Technical Support

to £18,000

Wholly owned subsidiary of worldwide financial information company seeks engineer with knowledge of PC networks, possibly with some programming background. The successful applicant will be ambitious, professional, and will be happy to work as part of a small team on all aspects of system support. Extensive European travel is possible, so a full EEC passport is preferable.

## 'C' Programmer

to £18,000

Major communications and telex software manufacturer requires 'C' programmer of at least 1 year's experience to complement existing Research and Development team. The successful applicant will preferably be a graduate, and will definitely be ambitious, conscientious, and a team player. In return the company offers a young, dynamic environment, full product training and excellent prospects for advancement.

## Analyst/Programmer

£ negotiable

RPG II Programmers, Analyst/Programmers with 6 months - 2 years experience urgently required. We currently have three clients, all committed to AS/400 within 12 months, all willing to retrain to AS/400, and all urgently seeking System 36 skills. Call Terry for immediate interview.

## COBOL Programmers - any hardware

to £20,000 + benefits

Major Dealer and Software House requires COBOL programmers for retraining to Ingres. Preferred additional attributes include a good education, UNIX experience, and possibly knowledge of some commercial 4GL. The only essential requirement, however, is a thorough knowledge of COBOL, as full retraining will be provided for the correct applicant.

## 'C' Programmers

to £20k + BENEFITS

```
#INCLUDE OPPORTUNITIES.h /* THE BEST AROUND */
#include EXPERIENCE.h /* 2 yrs + REQUIRED */
#define ENVIRONMENT "Development"
#define PACKAGE "Excellent"
main ()
{
    printf ("call now or send cv for early interview/n")
    printf ("we meet all relevant candidates/n evenings possible/n")
}
```

## RPG III/COBOL Programmers - AS/400 to £26,000

City based financial information company requires AS/400 Analyst/Programmers, preferably with RPG III on AS/400, although cross training will be provided from system 38. Also of interest is COBOL programming experience on S/3X or AS/400. In all positions a minimum of 18 months solid commercial programming experience is required, possibly within financial environments.

For an immediate interview regarding these and similar current vacancies, call or send/FAX your c.v. to the address below. Or, if you would prefer to contact us after office hours, call Terry on 02406 5892, or Paul on 01-398 0942.

# Roncom Recruitment

SEARCH AND SELECTION CONSULTANTS

46-47 Pall Mall, London SW1Y 5JG  
Telephone: 071-321 0245  
Fax: 071-839 7629



**Project Manager**  
M4/M25 to £27K+car  
A strong 'man-manager' with extensive development skills in PC systems, LANs and PC/IBM M/F systems is req. to push on with extensive development of this international datacentre. Ref: EXE 02

**PC Programmer**  
S/Countries to £22K+bens  
A solid background in applications development. PC development products and a desire to get involved in analysis are some of the key skills needed by this market leading IT systems house. Ref: EXE 03

**UNIX 4GLs**  
London/S.E. to £23K  
Min. 18 mths UNIX with exposure to COBOL, 'C' INFORMIX, ORACLE and CASE tools. S/W House ensures exciting projects. Ref: EXE 07

**'C' A/Progs**  
London to £20K  
Min. 2 yrs with 'C' developing POS type systems. Client interaction is a key role in this appointment. Super benefits pkge. Ref: EXE 08

**Software Engineer**  
Kent/Sussex to £19K+  
International group requires "client friendly" professionals with 'C' exp in PC/Windowing environment knowledge of real-time multi-tasking systems. Ref: EXE 09

**VAX Programmers**  
S/Countries to £20K  
A number of clients have needs for Progs. with 12 mths min. exp. using ORACLE, INGRES, C and 4GLs. Wide spectrum of projects and career opportunities. Ref: EXE 10

For further information about these opportunities, or the many other client needs that we have in London and throughout the Southern Counties telephone Gill McKay - Resources Manager. Alternatively Post or Fax your resume to us.

## PROJECT 3

I. T. RECRUITMENT SERVICES  
LIMITED

Keeley House, 22-30 Keeley Road, Croydon CR0 1TE  
Tel: 01 651 3218 (24 hrs) Fax: 01 651 3251

L O N D O N & S O U T H E R N C O U N T I E S

# Staff-Match

Recruitment Services Limited

## UNIX/INFORMIX/SQL

### Software Support

Surrey

Salary to £15,000

An excellent opportunity has arisen in the Software Support division of this leading international courier company. You will be involved in inhouse problem solving and supporting applications in the field. Experience in financial and accounting systems together with 12 months' UNIX/INFORMIX/SQL experience is desirable.

## UNIX/INFORMIX/SQL

### Post Sales Support

Middlesex

Salary to £20,000

This specialist Software House requires experienced self-motivated individuals to support Informix software. A minimum of 12 months' SQL experience is essential and UNIX desirable.

## 'C' Programmers

Surrey

Salaries to £13,000 + exc. benefits

Our client, a prestigious Assurance company, are currently recruiting 'C' programmers with as little as two months' experience. The successful candidates will also be trained in UNITY.

## UNIX/C/GRAPHICS/WINDOWS

### Software Engineers

Berkshire

Salaries to £21,000

This well established company, whose specialist area is image processing, are seeking well qualified, self-motivated individuals. You will be involved in all stages of a project life cycle, from requirement evaluation, systems design through to customer support.

## PC/UNIX/AIX/BASIC

### Programmers

Middlesex

Salaries to £15,000

Exciting opportunities exist within this major systems house who specialise in warehouse and point of sale systems. All that is required of you is to have 12 months' BASIC programming experience and have flair and initiative.

## UNIX/C/SSADM/YOURDON

### Senior Software Engineer

Hants

Salary to £22,000 + benefits

Our client, a high profile communications company, require a professional individual with design experience in a real-time/communications environment. The successful candidate will have a minimum of 2 years' design/programming experience using UNIX and 'C' and a structured methodology.

For further information, please telephone  
Allison Barnard on 048649 595 or evenings  
on 048649 780 or send your CV to

6 The Mews, The Common, Dunsfold, Surrey GU8 4LJ  
or Fax to 048649 739

## PORTMAN OFFER A BETTER CHOICE IN ANYONE'S LANGUAGE

**Unix Support** to £25,000 + Car  
(Herts)

Expanding Systems house with global interests.  
Key Skills: Very good Unix with a knowledge of C from a product support background. Self starter, well presented and happy to travel internationally. A knowledge of Uniplex would be ideal.

**'C' Analyst/Programmer** £20 - 30,000 Package  
(City)

Leading International Banking Group  
Key Skills: Minimum 3 years' experience in 'C'. Well educated with relevant financial experience, ideally Capital Markets. Development of front end dealing systems.

**C/Unix Development** to £20,000  
(Herts)

Established and expanding Systems House  
Key Skills: 12 months' programming in C/Unix. Graduates preferred who are keen to develop skills in Windows, Graphics and Expert Systems.

**Systems Developer/Analyst** £22,000 + Car  
(Middlesex)

Small and expanding consultancy, specialising in providing bespoke network solutions.  
Key Skills: Systems analysis and development in an IBM PC and Apple Mac environment. Development tools such as dBase/Clipper, 'C'. Design of multi-user systems for a variety of clients.

**Field Service Engineer** £18,000 + Car  
(South London)

Expanding dealership.  
Key Skills: 18 months' field service experience. Ability to install, configure, plan and support Unix and Novell based systems. Experience of X25 and X400 would prove useful.

**PC Support & Development** £14,000 + Benefits  
(City)

Medium size firm of Chartered Accountants.  
Key Skills: 1 year minimum in dBase III/Clipper, Lotus 1-2-3 and some graphics. A mixture of development and support. Age 20-25.

For further details, please contact, in confidence,  
Mark Bamber on 01-236 1113 or 06284-3695 evenings/weekends.

PORTMAN RECRUITMENT COMPUTERS  
15 GREAT SAINT THOMAS APOSTLE,  
LONDON EC4V 2BB





## Programmers & Analyst/ Programmers

## Bespoke Software Group (Crawley)

to £15,000

ROCC Computers, an independent, medium-sized British computer manufacturer, highly successful through innovation, is now seeking Programmers and Analyst/Programmers to work within the fast-growing Bespoke Systems Group, based at its headquarters in Crawley, West Sussex.

Committed to Unix, C and Unify/Accell, the Bespoke Systems Group specialises in the supply of tailor-made software solutions in a commercial environment.

You must be bright, ambitious and keen to work to the highest standards. You are likely to have around one or two years of successful development experience and be attracted by the prospect of working on a series of high-visibility assignments.

We offer personal recognition, remuneration based on merit, an optional company car, professional training and development and an equity participation scheme.

Please write with your full Curriculum Vitae, or telephone for an application form:

The Personnel Manager,  
ROCC Computers Limited,  
Kelvin Way, Crawley,  
West Sussex RH10 2LY  
Telephone 0293-31211

**ROCC**

The Total Solution for Your Future

(7212)

## SOFTWARE DEVELOPERS OXON & BUCKS

### PROGRAMMERS - C & ASSEMBLER

To £25,000 + Car

This highly successful Software House produces financial dealing room systems using industry standard software including DOS, OS/2 and NET-BIOS. As programmer you will develop leading edge software in a highly integrated operating environment which includes real-time processing, LANs, WANs and communications. Extensive C programming experience is essential. Experience of 286/386 assembly language is desirable.

### PC DEVELOPMENT - OS/2 & C

£15,000 - £19,000

Superb opportunity to make a significant contribution in a new project group working on the development of a major Retail Distribution system. Responsibilities include systems design, programming and support. Candidates should be experienced C programmers, have exposure to OS/2, PM, and have strong inter-personal skills. Positions also available for candidates with MS-Windows and PASCAL experience.

### PC DEVELOPMENT - FOXBASE/dBASE/CLIPPER

£15,000 - £22,000

Our client in the Financial Services market continues to make significant investment in the latest PC hardware and software development tools. PC analysts have accountability for the complete development life-cycle including requirements definition, systems design, programming and implementation. Candidates should possess excellent self-presentation and business analysis skills and be fluent in at least one database language.

To discuss your next career move in Oxfordshire and surrounding counties, call David Adcock in strict confidence on 0865-742456 & 7 or send your CV to:

Haybrook Appointments, Suite B, Regal Court,  
112 London Road, Headington, Oxford, OX3 9AU

**Haybrook**  
APPOINTMENTS



**PC Specialists**

## STOB - Don't give a XXXX

*'The hacker...left a stream of abusive messages and hollow threats... I don't think KYLIE MINOGUE is his real name' - report of a hacking attack on the HALFWITS bulletin board.*

*The scene: Daytime, exterior in a domestic yard. At the back of the set is a small wooden tools shed. There is an extremely conspicuous telephone cable rigged up to go in through its window. A young man, with an outrageous footballer's hair cut, enters the yard.*

SCOTT: G'day. Anybody at home?

HENRY (out of vision): Who's that?

SCOTT: It's me, mate.

*Henry appears from the house.*

HENRY: G'day.

SCOTT: G'day. I wondered if you had seen Charlene today?

HENRY: I think that she's fooling around with her stamp collection in this little hut again. Why?

SCOTT: I just had a look at my bank balance, and somebody's just paid \$25 million into it.

HENRY: That would be the third time this week.

SCOTT: Yeah. Call me suspicious if you like, but I'm beginning to think that something fishy is going on around here.

HENRY: And you think that cutie-Charlene has a hand in it? She's so nice, and clean, and wonderful.

SCOTT: Aw, don't say that, Henry. She's a

good Sheila, and not at all stuck up.

*(That's enough Python - Ed.)*

*Enter Jane, carrying a box which has MODEM printed on it in large letters.*

HENRY & SCOTT: G'day.

SCOTT: What have you got in there, Jane?

JANE: Just some new stamps for Charlene, Mister Nosy.

SCOTT: All right, keep your hair on.

*Jane goes into hut, closing door behind her.*

JANE (o/v): G'day, Charlene. I've got the new modem.

CHARLENE (o/v): That's great, Jane. Now we will be able to hack into more systems, steal money and leave anonymous, abusive messages on bulletin boards.

JANE (o/v): Great idea, Charlene.

SCOTT: Hey, Charlene!

CHARLENE (Opens door): Hello Scott. There's something important I've got to say to you.

SCOTT: Henry, me and little Todd are off to help Ernie, the arthritic donkey, find a new home.

CHARLENE: It's about us, Scott. I now know that I could never marry a man without his own 386-compatible, and subscriptions to half a dozen of the more interesting bulletin board services.

SCOTT: Ernie has just been callously abandoned, to fend for himself, in our modern, growing city of Melbourne. Some people are just unbelievable.

CHARLENE: Our relationship is on the rocks, Scott, sorry, Scott.

SCOTT: We are going to take some nice, juicy carrots. We wondered if you wanted to come along.

CHARLENE: Aw, you never listen to anything I say.

*She runs off in tears. JAPANESE TOURIST walks onto set, brandishing map of the London Underground.*

J/T: 'Scuse me. Please tell how to Cockfosters?

ENTIRE CAST: Drink it warm, mate!

J/T: Thank you velly much.

*Exits. Jane walks out of hut, carrying a personal computer.*

HENRY: What have you got there, Jane?

JANE: Just part of Charlene's stamp collection, Mister Nosy.

*Exits.*

SCOTT: 'Struth! Will you look at that! Call me suspicious if you like, but I think something's up with Jane and Charlene... (and so on, and on, and on.)

[.EXE]



## IMAGE PROCESSING

**Surrey to £17,000 + benefits**

Exciting opportunities exist within this rapidly expanding consultancy, with possible travel to USA, Far east and Europe.. People are needed with experience in Image Processing/ Recognition, 2D/3D graphics, UNIX, 'C' or Assembler to work on state of the art systems. Excellent benefits include flexitime, company pension and life assurance schemes together with a stimulating working environment and rapid career progression.

EXR383/A

## CAD SUPPORT

**Cambridge £11,500 to £19,000**

We are currently a world leader and to strengthen our position in the CAD/CAM market, we are looking for engineers to join our team responsible for ensuring that we release the highest quality products. You will have an engineering degree, together with some industrial experience and have a strong interest in advancing into CAD/CAM. Or, alternatively already have several years experience in a design or manufacturing environment using or supporting a CAD/CAM system.

A stimulating working environment awaits you, using the very latest VAXs, SUNs and PRIMEs in our newly equipped building.

EXR383/B

## FIRST CAREER MOVE?

**Hertfordshire to £19,000**

If you graduated at least 12 months ago and since then have gained solid 'C' experience, then this company would be extremely keen to talk to you about developing your career. They are probably the worlds leading systems developer of total office information and automation systems within the UNIX market place. They develop databases, graphical presentation systems using mixed colour full screen multi windows systems and much more.

EXR383/C

## UNIX 'HIGH FLYERS'

**Surrey to £25,000 + car**

This company must rank as one of today's most impressive organisations. Few companies can boast their level of achievement and success. In this role you will be working on the design of new CASE tools and database products within a structured environment. You will need to be of graduate calibre, with at least two years in-depth 'C' and UNIX experience.

EXR383/D

## SUN, 'C' & GRAPHICS

**Sussex £14,000 to £21,000**

This company is renowned for its work in the area of advanced computer integrated manufacturing systems. Current projects revolve round real-time data acquisition, communications and database applications, although there is a strong emphasis on graphical user Interface work using networked SUN workstations. They are currently seeking HND degree level candidates with at least 12 months solid UNIX and 'C' experience.

EXR383/E

## 'C' & UNIX CAD CAM

**North West to £25,000**

This major micro electronics design organisation is developing the latest state of the art VLSI chip design system. You should have excellent 'C' and UNIX experience gained in a workstation environment and ideally a knowledge of CAD development.

EXR383/F

## 'HIGH FLYERS' MOVE INTO CONSULTANCY

**London/Manchester £20,000 +**

Whatever your IT background, these openings represent the very best career opportunities available to young, ambitious computer professionals (with partnership and extremely high earnings possible by your mid thirties). However, we only seek the 'creme de la creme'. Candidates must have an excellent academic record (1st or 2i University degree) plus three to six years IT experience. Presentation and communication skills must be of the highest order: mobility is also important. To really accelerate your career, call today.

EXR383/G

## UNIX SUPPORT MANAGER

**Surrey to £35,000 + BMW + benefits**

This company must rank as one of today's most impressive UNIX workstation manufacturers. In this role you will act as a regional support manager responsible for three support profit centres. You will also act as a technical focal point for their prestigious accounts. They are seeking graduate calibre candidates with a proven UNIX software project or support management background.

EXR383/H

## RETRAIN IN X-WINDOWS

**Berkshire to £16,000**

This company develop some of the most impressive multi-window, full colour terminal emulation systems for the UNIX market place. Utilising X-Windows and DEC Windows they seek enthusiastic individuals to train in these environments. You should have a good technical degree and a minimum of 12 months 'C' and UNIX knowledge. If you have solid DOS and/or MS-Windows and seek to retrain, this organisation will give you the opportunity.

EXR383/J

## UNIX SUPPORT

**Hertfordshire £15,000 to £26,000 + car**

This major UNIX systems house has enjoyed a spectacular growth and continues to be a most powerful force in the UNIX marketplace. You will perform a highly technical post sales and consultative role for their diverse range of UNIX software tools. Of graduate calibre, you will need at least 18 months solid UNIX and 'C' experience. You may have gained your experience within a UNIX development or support environment, but above all you must have excellent interpersonal skills.

EXR383/K

## X-WINDOWS ARCHITECT

**Thames Valley to £25,000**

Regarded as one of today's most innovative and exciting development centres in Europe, you will be providing design and consultancy expertise for this company's collage Windowing system. You will act as a design authority utilising X-Windows and OSF/Motif. Strong contenders for this role will be degree qualified, together with at least three years UNIX and 'C' and around ten months or more X-Windows experience.

EXR383/L

## SECURITY CONSULTANTS

**Hampshire all levels £13,500 to £30,000 + benefits**

A computer systems security policy comprises three elements: communications security; computer security; and operational security. This unique software company addresses all three areas and is believed to be Europe's largest specialist team with indepth knowledge of computer and communications security. With a largely untapped marketplace, its future success looks guaranteed and in order to keep abreast of continued demand for their services, they now require computer professionals with the following areas of expertise:

'C' and UNIX ★ Assembler (ideally M68000) ★ Low level hardware and firmware knowledge ★ 4GL and SQL experience ★ Project Managers Workbench ★ COMPUSEL knowledge ★ Secure Operating Systems ★ Gould ★ Formal methods ★ INGRES RDBMS Design & Prog.

EXR383/M

## VIDEO GRAPHICS

**Thames Valley £14,000 to £22,000**

In this role you will be engaged on the software design of digital graphics products including video and animation software and image processing primitives. You will need at least 18 months postgraduate experience in writing real-time software (in 'C' or Pascal) to drive hardware systems.

EXR383/N

## 'C' COMPILERS

**Thames Valley £14,000 to £19,000**

This small but highly acclaimed development group are engaged in the design of 'C' translators and compilers for use on ultra fast RISC based workstations. This position would certainly suit a graduate calibre software engineer with at least twelve months UNIX development experience, seeking a truly advanced research environment.

EXR383/P

## OPEN SYSTEMS CONSULTANTS

**London to £35,000 + car + benefits**

This company must rank as one of the top 'City' consultancies. They are currently seeking degree level candidates with at least five years in-depth experience in one of the following areas: UNIX and networking, OSI COMMS, RDBMS. As a Principal Consultant you will conduct high level technical assignments within major blue chip organisations.

EXR383/R

Name (Mr. Miss. Ms. Mrs.) \_\_\_\_\_  
 Address \_\_\_\_\_  
 Post Code \_\_\_\_\_  
 Home Tel: \_\_\_\_\_ Day Tel: \_\_\_\_\_ Ext: \_\_\_\_\_  
 General enquiry only - tick box ☐ I have enclosed my C.V. - tick box ☐ Advert Ref No: **EXR383**

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Natural selection provides unique  
passive protection for the porcupine.

# The Activator - Natural Selection For Software Protection



Inventor and entrepreneur  
Dick Erett explains how  
"The Activator" provides  
sane protection for your in-  
tellectual property.

**I**n any industry, just as in nature, the process of natural selection raises one solution above another. Natural selection is the most elegant of engineers.

In the area of software protection The Block has been selected by the marketplace as the solution that works. Over 500,000 packages are protected by our device.

For the past 4 years our philosophy has been; 'You have the right and obligation to protect your intellectual property.'

## A New Ethic For Software Protection

In allowing end-users unlimited copies of a software package and uninhibited hard disk and LAN operation, The Block has created a new ethic for software protection.



**"On-the-fly" programmable memory option now available for  
OS/2, MS-DOS and Macintosh**

By removing protection from the magnetic media we remove the constraints that have plagued legitimate users.

They simply attach our key to the parallel port and forget it. It is totally transparent, but the software will not run without it.

## A New Technology For Software Protection

Our newest model, The Activator, builds on our current patented design, and establishes an unprecedented class of software protection.

We have migrated and enhanced the circuitry of The Block to an ASIC (Application-Specific Integrated Circuit) imbedded in The Activator.

This greatly improves speed and performance, while reducing overall size. Data protection can also be provided.

## Programmable Option

The Activator allows the software developer the option to program serial numbers, versions, or other pertinent data known only to the developer, into the circuit, and access it from the program.

Once you program your part of the chip, even we have no way to access your information.

The ASIC makes emulation of the device

virtually impossible. It also presents an astronomical number of access combinations.

## Full 100% Disclosure

Since The Activator is protected by our patent we fully disclose how it works. Once you understand it, endless methods of protection become evident.

Just as no two snowflakes are the same, no two implementations of The Activator are identical. And like the snowflake the simplicity of The Activator is its greatest beauty.



We never cramp your programming style or ingenuity. Make it as simple or complicated as you desire.

Let us help safeguard what's rightfully yours. Please call today for additional information or a demo unit. *It's only natural to protect your software.*



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